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ILLINOIS RIVER SYSTEM - STREAM FLOWS REQUIRED FOR WATER QUALITY CONTROL

Public Health Service
Chicago, Illinois

March 1963

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SPECIAL REPORT ON STREAM FLOWS REQUIRED FOR WATER QUALITY CONTROL IN THE UPPER ILLINOIS RIVER SYSTEM

March 1963

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control
Great Lakes-Illinois River Basins Project

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INTRODUCTION

This report presents the results of estimates of total stream flows, as measured at Lockport dam, required to maintain improved water quality in the system of channels between Lake Michigan and the confluence of the Des Plaines River with the Chicago Sanitary and Ship Canal--exclusive of the Calumet-Sag channel. Results are given for two situations: 1) existing conditions of waste inputs to the streams, and 2) existing conditions modified by the assumed implementation of certain improvement measures as discussed in Public Health Service reports entitled, "Recommended Measures for Improving Water Quality", (1)* and "Effects on Water Quality of Recommended Improvement Measures" (2).

The data on which these computations are based are set forth in the report on "Water Quality Conditions" (3). Field survey data specifically utilized covered the following month-long sampling periods: April-May 1961, June 1961, July 1961, August 1961, and January 1962.

The water quality goals used in estimating flow requirements in this report are as follows:

Coliforms:

Interim Goal--Monthly geometric mean coliform density of 10,000 per 100 milliliters.

Ultimate Goal--Maximum coliform density of 5,000 per 100 milliliters on the basis of monthly geometric means, and further, the density of 5,000 coliforms per 100 milliliters should not be exceeded in more than 20% of the samples examined during any one month.

Dissolved Oxygen:

Interim Goal--Not less than 3.0 milligrams per liter (mg/l)

Ultimate Goal--Not less than 5.0 mg/l

Alkyl Benzene Sulfonate (ABS):

Not more than 0.5 mg/l just below the confluence of the Des Plaines River with the Kankakee River

Previous reports have set forth "Recommended Measures for Improving Water Quality" (1) and have evaluated the "Effects on

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*Numbers in parentheses, thus (1), refers to References listed at end of Report.

Water Quality of Recommended Improvement Measures" (2). The reduced organic loads set forth in the latter report have been used in estimating stream flows that would be required if the recommended improvements are accomplished.

In the waterway system known as the Calumet-Sag, from Calumet Harbor to the Blue Island Lock, there are frequent, very low flows and reversals of flows. These conditions complicate the application of accepted water quality relationships that exist in normal flowing streams. From the results of laboratory analyses and flow measurements available, it is evident that additional stream flows will be needed for water quality control in the Calumet-Sag system. An undetermined portion of the additional flows required at Lockport should properly be assigned to the Calumet-Sag Channel. Such a diversion of flows would not materially affect the estimates of total requirements given herein, since the critical points for quality control in the whole system are located farther downstream.

STREAM FLOWS BASED ON DISSOLVED OXYGEN CRITERION

Domestic sewage and organic industrial wastes are stabilized by a combination of physical, chemical, and biological actions. Under natural aerobic stream conditions, self-purification action satisfies the oxygen requirements of organic pollution loads, thus converting the substances to non-putrefactive material. When the dissolved oxygen has been totally depleted, anaerobic decomposition of unstable organic material takes place--accompanied by the release of odorous gases, and generally undesirable conditions which tend to impair and discourage most water uses. Thus, biological transformations under aerobic conditions are desired. In the Upper Illinois River System, serious shortages of dissolved oxygen exist in certain reaches during critical times of the year. These levels have been below 3.0 mg/l on the basis of monthly averages, and zero daily results are common in the summer. The desired DO level may be maintained by control and reduction of organic pollution, by added stream flow, by aeration of the stream itself, or by a combination of these measures.

Biological action and the accompanying oxygen utilization vary with temperature, being greater in the warm summer months and lower in the colder winter months. As a result, the average amount of stream flow needed to maintain a desirable minimum dissolved oxygen (DO) concentration will vary from month to month and from year to year.

The estimation of flows necessary to maintain dissolved oxygen concentration at or above 3.0 mg/l has been based upon the critical minimum dissolved oxygen concentration determined in dissolved oxygen-biochemical oxygen demand (DO-BOD) balance computations. The discussion and computations in the analysis of DO results under existing conditions during five month-long study periods are presented in Chapter IX of the report on "Water Quality Conditions" (3) and the computations are summarized in BOD-DO Tables IX-4 to IX-13 of that report. For existing conditions with recommended improvement measures in effect, the computations are summarized in Tables 8 through 17 of this report.

The BOD-DO balance computations include consideration of changes in BOD and DO between sampling stations. These mid-station effects can be positive or negative in their influence on BOD and DO tests at sampling stations. The computations include the effects of flowing demand (dissolved and suspended material having a BOD) sludge deposits, reaeration, the influences of tributary inflows, known industrial wastes, the major treatment plants, and some unknown source loads. The known source loads during existing conditions are summarized in Table 3. The estimated source loads under improved conditions are summarized in Table 18.

The BOD satisfied in the waterway as it flows between stations is identified as satisfied flowing demand, and is illustrated in the figures "Integration of Pollutional Loads", for existing and improved conditions. The BOD satisfied between stations would be the difference in the ordinates at consecutive stations if there were no mid-station changes. With mid-station changes, the flowing demand that is satisfied is the sum of the two ordinate changes in the two steps between the consecutive stations. The downward sloping line to the right illustrates BOD that is being satisfied by the oxygen assets of the stream.

The mid-station changes are shown as being in the middle of each reach. This is for convenience in computations only. These mid-station changes are mainly from storm spillage, bottom sludge demands and industrial waste loads. The computations for calculated mid-station loads under existing conditions are summarized in Table 4.

The oxygen demands of sludge deposits are based on changes in the DO profile and the computed or otherwise determined values for the flowing demand and reaeration for each reach of the stream. Drops in the DO profile indicate a reduction in the oxygen assets, and in the absence of other known demands are attributed to sludge demands. The calculated oxygen demands that are attributed to bottom sludge demands for existing conditions are summarized in Table 5. A detailed discussion of bottom sludge oxygen demand is presented in the report on "Water Quality Conditions" (3) Chapter IX, "The Impact of Waste Loads on the Stream."

The Model Year

For estimating required flows, it was necessary to develop conditions of stream flow, load, and temperature. These are the principal variables affecting water quality parameters. Estimates were made by developing what is termed a Model Year, defined as a year in which the flow, load, and temperature for each month approximates as closely as possible the average stream flow, organic loading and temperature from a selected study period of record.

The Model Year of twelve months was developed from the average temperatures of the main channel at Lockport, as observed by the Project for its five sampling periods, and from the average temperatures for each of the twelve months of the four years 1959-1962, inclusive, obtained from MSD reports.

On this basis of temperatures, the sampling period of April-May 1961, was considered to be representative of the model months of April, May, October, and November. The June 1961, sampling period was considered representative of the model month of June. The July 1961, sampling period was considered to represent the months of July and September in the model. The August 1961, sampling period represents August; and the January 1962, sampling period represents the model months of December, January, February, and March. Basic temperature data used in developing the Model Year are shown in Table 7.

The estimates of stream flows to meet dissolved oxygen requirements have been based upon evaluation of pollution loads, flows, sludge demands, atmospheric reaeration, temperatures, and the reduction in stream loadings by the recommended improvement measures. With agreement reached between calculated and observed oxygen, it is possible to estimate required stream flows with confidence. An intricate and dynamic biochemical process, sensitive to environmental changes is involved. Furthermore, this process takes place in a complex waterway system. These factors tend to increase the difficulties of making estimates. Nevertheless, the results secured by the method used are believed to present a reasonably accurate prediction of the flow requirements necessary to achieve the conditions outlined.

The estimates given herein of flows required for DO control do not provide for unusual conditions such as occurred in September 1961. In that month the abnormally high local runoff produced stream flows in excess of the amount required for water quality maintenance; nevertheless, the flow was chargeable against allowed diversion. Efficient utilization of allowed diversion would be assisted by the proposal for balancing flows over a water year starting March 1, rather than a calendar year. This was discussed in the previously-cited report on measures for improving water quality (1).

Stream Flows Required for Existing Conditions

Existing conditions are considered to be those reflected by the results obtained during the five month-long study periods through the model year concept. After the BOD-DO balance computations were completed, the additional stream flows required to bring in additional DO was as an approximation by a direct dilution computation. This method was given a check in one instance by a BOD-DO balance computation and found to agree reasonably well. As indicated by need a more accurate estimate can be developed by successive approximations as was done in estimating stream flows required with improvements in effect.

The BOD-DO balance summaries for existing conditions for the five study periods are in Table IX-4 to IX-13, of Chapter IX of the report on "Water Quality Conditions" (3). The BOD and DO profiles are shown on Figures 1 through 10. The summary of assets and liabilities for the five study periods is given in Table 6.

The low points for monthly average DO for the study periods used to make up the Model Year were as follows:

Study Period	Minimum DO	Station
April-May '61	0.58 mg/1	SS 292.1
June '61	0.39 "	SS 296.2
July '61	1.01 "	NB 325.8
	0.21 "	SS 296.2
Aug. '61	0.26 "	NB 325.8
	0.36 "	SS 296.2
Jan. '62	4.92 "	SS 291.1

Estimates were made of stream flows required to maintain a DO concentration of 3.0 mg/1 for each of the five study periods. For four of these periods, additional flow would be needed. In January, flow could be reduced. The model year estimates as developed, are shown in Table 1.

The required annual average total flow needed at Lockport to maintain a DO concentration of 3.0 mg/1 was estimated to be 4450 cfs. This would be distributed as follows:

Des Plaines River Watershed Runoff	170
Domestic Pumpage and Return	1790
Additional Flow Required to Maintain 3.0 mg/1 DO	2490
Total Flow at Lockport	4450

Stream Flows Required With Improvements in Effect

The report on "Effects on Water Quality of Recommended Improvement Measures" (2) evaluated these effects in terms of pounds of BOD removed as measured at the facility. The following is largely quoted from the summary of that report with an adjacent column added to indicate the effect of the recommendation on reducing the pollution load in the mainstem of the Upper Illinois River System. The difference represents the natural purification between the facility and the mainstem.

	Estimated Pollution Reduction by Recommended Improvement Measures in Pounds of Ultimate BOD/day	
	At Facility	In Mainstem
Adequate secondary treatment at 16 communities or institutions that are tributary to the river system between Lake Michigan and Lockport.	10,000	5,000
Chlorination of MSD sewage treatment plant effluents.	38,000	35,000
Connection of known inadequately treated industrial wastes to secondary treatment facilities, or adequate on-site treatment between Lake Michigan and Lockport.	26,000	22,000
Storm Relief Correction	32,000	32,000
Enactment and action under an ordinance allowing MSD to assess sewer service charges based on quantity and characteristics of industrial wastes to induce industries to decrease waste discharges to sewage treatment plants.	10,000	10,000
Planned additional capacity at MSD treatment plants to decrease storm spillage at the plants.	6,000	6,000
TOTALS	122,000	110,000

The effects of the recommended improvements as outlined above were integrated into balances, and by successive approximations, the additional flow needed for the DO objective was obtained.

With improvements in effect and adjusted stream flows, the computed DO for four of the five study periods was below 3.0 mg/l. The fifth study period was in January 1962, when the minimum DO was above 3.0 mg/l. Again, by successive approximations, this time with added stream flows, the DO level was brought up to 3.0 mg/l in the critical reaches.

The estimated required flows for the DO concentration of 3.0 mg/l were used to make up the model year of 12 months based upon five months of sampling study. The summaries are in Table 2, and the flow distribution summaries are in Table 22.

With the improvement measures in effect, the required annual average total flow at Lockport to maintain a DO concentration at or above 3.0 mg/l throughout the channel system was estimated to be 3,760 cfs. This would be distributed as follows:

Des Plaines River Watershed Runoff	170
Domestic Pumpage and Return	1790
Additional Flow Required to Maintain 3.0 mg/l DO.	1800
Total Flow at Lockport	3760 cfs

DILUTION TO MEET ABS GOALS

Alkyl benzene sulfonate (ABS) is the common name for a group of similar compounds that are present in most synthetic detergents. Most of the ABS molecules are highly resistant to biological degradation. Sewage treatment processes have little effect on molecules that have resisted biological treatment. These molecules also resist subsequent biological action in the stream.

The recommended limit for ABS of the U. S. Public Health Service Drinking Water Standards is a maximum concentration of 0.5 mg/l. This limit has been selected with application at Station I.R. 271.6, just below the confluence of the Des Plaines River with the Kankakee River.

Sampling of the Upper Illinois River System for ABS was limited to samples taken from the three MSD sewage plant effluents in September 1961, and to samples from the mainstem of the river in January 1962. The estimated annual average additional flow required to attain the recommended objective is based upon the September 1961, samplings. Table 20 show the summaries of the September 1961, samplings and the January 1962, samplings. This data is summarized as follows:

1. The September 1961, plant-measured concentrations of ABS were projected downstream to Station IR 271.6.
2. The ABS input to the stream in September 1961 was adjusted for storm overflow. During that month, there were very heavy rain storms in the Chicago area. The yearly average flow at Lockport in 1961 was 3411 cfs; the September flow was 5000 cfs. An estimate was made for the ABS that went from the combined sewers directly into the river thru the storm overflows without going through the treatment plants. The adjusted total ABS input to the stream system in the Chicago area was an estimated 26,100 pounds per day, annual average. Projected downstream, this figure corresponds to a yearly average ABS concentration of 0.77 mg/l at Station IR 271.6.
3. The river system was sampled in January 1962, at which time the average load in transport at Station SS 300.5 was found to be 25,700 pounds of ABS per day. The close agreement of this figure with the previously-cited 26,100 pounds per day seems to confirm the reasonableness of the estimates.

For Existing Conditions

To reduce the computed ABS concentration of 0.77 mg/l to 0.5 mg/l would require an additional dilution flow of 4330 cfs.

The total flow at Station IR 271.6 would then be 12360 cfs, and the corresponding flow at Lockport would be 7740 cfs.

The summaries of the computations for the estimated average annual dilution requirements for ABS at Station IR 271.6, the control point, and at Lockport Dam, are shown in Table 19.

With Recommended Improvements in Effect

The recommended improvements for small treatment plants (4), industrial waste treatment, and industrial waste ordinance would have practically no influence on ABS in the river system. The treatment plant improvements recommended, consisting of chlorination of final effluent, would not reduce the ABS content of discharged effluents significantly. The dilution needs to secure ABS control would be the same as for existing conditions, as discussed above.

DILUTION TO MEET COLIFORM GOALS

In an earlier report "Effects on Water Quality of Recommended Improvement Measures" (2) it was pointed out that coliform densities in the Upper Illinois River System could be reduced by instituting chlorination. It was shown that chlorination of the effluents at the existing MSD plants alone would not fully achieve the coliform goals even though all sewage originating in the Metropolitan Sanitary District were treated and chlorinated, and that consideration should also be given to the feasibility of chlorinating the main channel of the Upper Illinois River System at strategic locations. Estimates of expected coliform density at the various sampling points were presented in Table 2 of the aforementioned report (2). This table is repeated here as Table 21, and shows in Column 4 the estimated coliform levels that might be achieved if all sewage were treated and chlorinated, and in Column 5 the alternative wherein only sewage now reaching the MSD plants is assumed to be treated and chlorinated.

A review of the estimated levels in Column 4 shows several locations which would be above the levels of 10,000 coliforms per 100 ml required to meet the interim goal established and that nearly all locations would be above the ultimate goal of 5,000 coliforms per 100 ml.

It is apparent that these goals would not be achieved without certain additional measures to reduce the coliform density. The additional measures that could be applied would be the further dilution of waters of the main channels of the Upper Illinois River System with the cleaner waters of Lake Michigan or possibly the direct chlorination of the main channels at strategic points.

In considering the attainment of the coliform goals by increasing stream flow, the quality of the water available must be considered as well as the coliform density in the main channel. In column 4 of Table 21, the estimated coliform densities at sample points NB 331.4, NB 329.0 and NB 325.8 are at or above the recommended levels. The water available at NS 340.7 contains an average density of 200 per 100 ml. The highest density, at NB 325.8, of 25,000 must be reduced to 10,000 to meet the interim goal, and to 5,000 to meet the ultimate objective. Calculations on a straight dilution basis of the amount of dilution water required to achieve these goals are illustrated as follows:

Sampling Point	Present average flow, cfs	Total Flow in cfs needed to meet coliform goals of	
		10,000/100 ml	5,000/100 ml
NB 325.8	1194	3,020	6,170

To achieve these goals at NB 325.8 would require 1830 cfs additional dilution, at the Wilmette intake for the interim goal of 10,000 coliforms/100 ml, and 4970 cfs additional dilution for the ultimate goal of 5000 coliform/100 ml. With the present average flow at Wilmette of 700 cfs, the additional flow requirements would be nearly tripled to meet the interim goal, and would be seven times greater to meet the ultimate goal.

Similar computations for the Cal-Sag Channel show need for a four-fold increase in flow (600 cfs to 2860 cfs) to meet the interim goal of 10,000 coliforms per 100 ml and up to 9250 cfs to meet the ultimate goal of 5000 coliforms per 100 ml for that section of the main channel of the Upper Illinois River System. These additional flows might exceed the capacity of the channels to carry the additional water.

In view of the excessive flow requirements and because other means for controlling coliform densities can be exercised, this method of control may be considered impractical.

The practicability of chlorination to reduce coliform densities to satisfactory levels has been long accepted and practiced by public health authorities. The use of this technique to control coliform densities in the main channels of the Upper Illinois River System would be technically feasible. Chlorine requirement, techniques of application and control, and economic considerations remain to be developed. One further advantage of this technique would be the continuous control that would be possible, which would tend to smooth out large fluctuations in coliform density, particularly as a result of storm water runoff.

SUMMARY

This report recognizes that, even with the recommended measures in effect, additional stream flows will be required for water quality control in the Upper Illinois River System. Estimates have been made to show the stream flow that would be needed; first, under existing and, second, under improved, conditions. The summaries are for the two conditions on the basis of yearly averages computed from observations during five month-long study periods. The estimates predict the action of a complex biochemical process based on observed conditions. While this procedure is not exact, the estimates are believed reliable.

Summaries of the conclusions for maintaining a DO concentration at or above 3.0 mg/l are in Tables 1 and 2. Accordingly, the minimum yearly average stream flow under existing conditions would be 2490 cfs, and a total flow at Lockport of 4450 cfs. With the improvement measures in effect, the minimum yearly average stream flow required would be 1800 cfs, and total flow at Lockport 3760 cfs. No provision has been made in these estimates for unusual rainfalls. Replacing the calendar year with a water year, running from March first, as the period for balancing allowed annual diversion, would be more effective for water quality control. Permission to balance over a period of more than one year would also be advantageous, to compensate for times of abnormal weather.

To meet the ABS objective, the computations indicate that there would be needed an additional flow of 4300 cfs, and a total flow at Lockport of 7700 cfs. The required flows under the improved conditions would be the same as under existing conditions. In view of the advances in research toward developing biodegrabable detergents, such development promises a more practical solution to this problem than does increasing stream flows.

The additional stream flow needed to attain the coliform objective may be impractical; chlorination of plant effluents and consideration of chlorination of the mainstem offer some promise.

REFERENCES

1. *Recommended Measures for Improving Water Quality*, Great Lakes-Illinois River Basins Project, U. S. Public Health Service, January 1963.

2. *Effects on Water Quality of Recommended Improvement Measures*, (companion report to Reference 1., above).

3. *Water Quality Conditions*, Great Lakes-Illinois River Basins Project, U. S. Public Health Service, January 1963.

4. Special Report on Water Quality Goals for the Upper Illinois River System.

5. Hurwitz, E., and others. "Assimilation of ABS by an Activated Sludge Treatment Plant Waterway System", *Journal, Water Pollution Control Federation*, 32, 1, p. 1111, October 1960.

TABLE 1

ESTIMATED ANNUAL AVERAGE FLOW -- SANITARY AND SHIP CANAL AT LOCKPORT (STN. #22/SS291.1) TO MAINTAIN A DISSOLVED OXYGEN CONCENTRATION OF 3.0 MG/L IN MAINSTEM OF UPPER ILLINOIS RIVER SYSTEM

FLOWS BASED ON EXISTING CONDITIONS DURING STUDY PERIODS

Month Model Year (1)	Surface Runoff (3) D. P. W. R. cfs	Domestic Pumpage cfs	Total Dilution Diversion Required (2) cfs	Total Required Flow at Lockport cfs	Remarks
January	170	1720	770	2660	Base DO over 3.0 mg/1
February	170	1720	770	2660	Base DO over 3.0 mg/1
March	170	1720	770	2660	Base DO over 3.0 mg/1
April	210	1690	3020	4920	
May	210	1690	3020	4920	
June	120	1900	3210	5230	
July	120	1960	3850	5930	
August	110	2050	3830	5990	
September	120	1960	3850	5930	
October	210	1690	3020	4920	
November	210	1690	3020	4920	
December	170	1720	770	2660	Base DO over 3.0 mg/1
Annual Average	170	1790	2490	4450	

(1) Model Year based on DO objective computed from five monthly study periods: April-May 1961, June 1961, July 1961, August 1961, January 1962.

(2) Values in dilution columns include surface runoff charged as dilution flow.

(3) Values in D.P.W.R. column are not part of dilution flow, but are included in flow measured at Lockport.

(4) An assumption in the calculations is that the only change in the stream characteristics caused by the additional flow is the addition of dissolved oxygen.

TABLE 2

ESTIMATED REQUIRED ANNUAL AVERAGE FLOW - SANITARY AND SHIPCANAL AT LOCKPORT (STN. 22: SS 291.1)
TO MAINTAIN A DO CONCENTRATION OF 3.0 MG/L IN MAINSTEM OF UPPER ILLINOIS RIVER SYSTEM
FLOWS BASED ON EXISTING CONDITIONS DURING STUDY PERIOD WITH RECOMMENDED MEASURES IN EFFECT

AVERAGE FLOWS -- CFS				
Month Model Year[1]	Surface Runoff D.P.W.R.[2] cfs	Domestic Pumpage	Dilution Flow Required for Objective[3] Dissolved Oxygen Minimum Average 3.0 mg/1	Practical Ruling Flow cfs
Jan.	170	1720	630	2520
Feb.	170	1720	630	2520
Mar.	170	1720	6630	2520
Apr.	210	1690	2190	4090
May	210	1690	2190	4090
June	120	1900	2120	4140
July	120	1960	2740	4820
Aug.	110	2050	2700	4860
Sept.	120	1960	2740	4820
Oct.	210	1690	2190	4090
Nov.	210	1690	2190	4090
Dec.	170	1720	630	2520
Annual Average	170	1790	1800	3760

[1] Model Year based on DO objective computed from five monthly study periods: April-May 1961, June 1961, July 1961, August 1961, and January 1962.

[2] Values in D.P.W.R. column are not part of dilution flow, but are included in flow measured at Lockport.

[3] Values in dilution columns include surface runoff charged as dilution flow.

The computed dilution flows required for the DO objective have been checked in BOD-DO balances.

TABLE 3

KNOWN SOURCES BIOCHEMICAL OXYGEN DEMAND LOADS
UPPER ILLINOIS RIVER SYSTEM MAINSTEM
L-U Ultimate BOD in pounds per day

Source	April-May 1961	June 1961	July 1961	August 1961	January 1962	Averages (5 periods)
Station No. 1	27960	26070	15060	10990	890	16,190
NSSTP	18180	23150	19490	29820	29560	24,040
N.R.N.Br.Chgo.R.	7470	2210	1840	950	3590	3,210
Chicago River	12000	11430	12780	8030	10020	10,850
S-SWSTP	101460	171590	100020	97470	140500	122,210
Cal-Sag Channel (39)	28500	20850	22750	13070	22200	21,470
Totals	195,570	255,300	171,940	160,330	206,760	197,970

Estimated Average Mid-Station Changes from 5 Study Periods:
+ Loads = + 157250 Ultimate BOD pounds per day
- Loads = - 82900 " " " " "

Estimated Annual Average Storm Spillage based on Study of 31 Storms = 56000 Ultimate BOD pounds per day
Estimated Industrial Waste & Mal-functioning Storm Relief Loads = 54300 " " " " "
Total =110300 Ultimate BOD pounds per day

Loadings Accounted for: $\frac{110300}{157250}$ = 70%

TABLE 4

ESTIMATED MID-STATION BIOCHEMICAL OXYGEN DEMAND CHANGES
UPPER ILLINOIS RIVER SYSTEM MAINSTEM
L-U Ultimate BOD in pounds per day

Station Reach	April-May 1961	June 1961	July 1961	August 1961	January 1962	Remarks
1-2	+240	-1000	-1770	-2730	+290	
2-3	+3480	+3700	+2670	+4900	+1200	
3+NSP-4	+13540	+4500	-9550	-10180	-50	
4-5	-7930	+5600	+4910	-2920	-3410	
5+6-7	-7770	+3600	-1070	-230	-2200	
7-8	+17210	+27500	+13450	+10630	-1170	Low velocity: large drainage area
8-9	+6760	-11900	+5380	-1980	-1910	
9+Chicago R. - 12	-13280	-8000	-5290	-5290	-1970	
12-13	+4600	+7500	+3420	+5200	+1510	
13-14	+8090	+32000	+16540	+21000	+7470	Low velocity: large drainage area
14-15	+12520	+26000	+10690	+28550	+17690	Low velocity: large drainage area
15+S-SWP-16	+64210	-61000	+85860	+4810	+6560	Low velocity: large drainage area
16-17	+14700	+24000	+15210	-5510	-20490	Low velocity: large drainage area
17-18	-26790	+39000	-44450	-9680	-8780	
18+C.S.-19	-4540	-66000	+18990	+40540	+3120	
19-20	-7700	+35000	-15920	-4160	-6590	
20-21	+13270	+25000	+38380	+19910	-11230	Decreased velocity above dam
21-22	-9080	-7000	+1020	+2280	+2070	
Des Plaines R.	--	--	--	--	--	
Totals	+158,620 - 77,090	+233,400 -154,900	+216,520 - 78,050	+137,820 - 42,680	+39910 -57800	Average + 157,250 Average - 82,900

TABLE 5
NET BOTTOM SLUDGE-DISSOLVED OXYGEN DEMAND
BASED ON DIFFERENCE BETWEEN OBSERVED AND CALCULATED DO DROP BETWEEN CONSECUTIVE SAMPLING STATIONS
UPPER ILLINOIS RIVER SYSTEM MAINSTEM

	POUNDS BOTTOM SLUDGE OXYGEN DEMAND/DAY					
Station Reach	April-May 1961	June 1961	July 1961	August 1961	January 1962	Remarks
1-2	-	-	-	640	170	
2-3	1100	1200	2010	3140	700	
3-NSP	-	-	-	-	-	
NSP-4	670	2900	3600	3670	6190	Below plant outfall
4-5	60	1600	3600	3430	1000	Large storm drainage area
5+6-7	9990	13580	7700	11140	5130	Large storm drainage area
7-8	9700	11630	15170	13370	2920	Large storm drainage area
8-9	3920	3730	5500	6900	-	
9-J. Chicago R.	-	-	-	-	-	
9+J-12	-	-	-	-	-	
12-13	3350	5370	950	11520	-	Large storm drainage area
13-14	-	-	-	-	-	
14-15	-	-	-	1920	-	
15-SWP	-	-	-	-	-	
SWP-16	1580	570	11120	10130	24050	Below plant outfall
16-17	23910	3000	-	7580	5470	
17-18	2520	-	-	-	2200	
18-J.C.S.	-	-	-	-	-	
J.C.S.-19	-	-	-	-	4160	
19-20	210	-	-	-	-	
20-21	-	-	-	-	350	
21-22	-	5690	410	-	10890	
22-J.D.P.R.	-	-	-	-	-	
Total	57030	49270	50060	73410	63230	

Total for 5 periods 293000

Average - 58600 pounds Oxygen per day

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TABLE 6

SUMMARY OF ASSETS AND LIABILITIES IN UPPER ILLINOIS RIVER SYSTEM MAINSTEM FROM WILMETTE (NS 340.7) TO LOCKPORT (SS 291.1)

EXISTING CONDITIONS

STUDY PERIOD	ASSETS			LIABILITIES					STATION 22 (LOCKPORT) SS 291.1	
	Tributary DO lb/da	Reaeration DO lb/da	Est. DO added lb/da	Known BOD Loads lb/da	Estimated Midstation BOD Loads lb/da Added +	Deposit -	Estimated B.S.O.D. Satisfied lb/da	Est. Flowing BOD Satisfied lb/da	DO lb/da	BOD lb/da
April-May 1961	153 680	51 050	32 630	195 550	158 600	77 090	57 030	141 120	22 550.	144 510
June 1961	143 920	56 860	61 360	255 300	233 400	154 900	49 270	181 570	10 690	153 320
July 1961	128 280	60 920	60 430	171 930	216 510	78 050	50 060	175 300	8 390	143 260
August 1961	118 780	63 120	37 100	160 330	137 820	42 680	73 410	137 380	8 710	116 120
January 1962	176 220	31 140	24 160	206 760	39 910	57 800	63 230	81 060	85 020	111 970
Totals	720 880	263 090	215 680	989 870	786 240	410 520	293 000	716 430	135 360	669 180
Averages	144 180	52 620	43 140	197 970	+ 157 250	- 82 100	58 600	143 290	27 070	133 840

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TABLE 7

MODEL YEAR FROM MONTHLY STUDY PERIODS BY GREAT LAKES-ILLINOIS RIVER BASIN PROJECT

AVERAGE TEMPERATURES OF MAIN CHANNEL AT LOCKPORT

	MSD DATA				ARITH.	STAND.	GL-IRBP		MODEL YEAR	BASED ON
MONTH	1959	1960	1961	1962	AVE.	DEV.	1961	1962	GROUPINGS	GL-IRBP STUDY
DEC.	8.5	8.0	8.0	N.A.	8.17	0.292				Jan. 1962
JAN.	3.5	6.5	6.5	5.0	5.38	1.436		7.21	Dec-Jan-Feb-Mar.	Jan. 1962
FEB.	5.5	6.0	9.0	6.0	6.62	1.601				Jan. 1962
MAR.	10.0	7.0	10.5	9.0	9.12	1.548				Jan. 1962
APR.	15.0	12.5	12.5	15.0	13.75	1.443				Apr-May 1961
MAY	22.0	17.5	18.0	20.5	19.50	2.121	A-M 18.6		Apr-May-Oct-Nov.	Apr-May 1961
JUNE	22.5	22.5	23.5	24.5	23.25	0.958	24.0		June	June 1961
JULY	28.0	27.5	26.5	26.5	27.12	0.750	27.2		July-Sept.	July 1961
AUG.	27.5	28.5	27.5	27.5	27.75	0.500	29.0		Aug.	Aug. 1961
SEPT.	25.0	27.5	24.0	24.5	25.25	1.555				July. 1961
OCT.	18.5	21.0	21.0	21.0	20.38	1.250				Apr-May 1961
NOV.	12.0	14.0	15.0	14.5	13.88	1.315				Apr-May 1961
YR AVE	16.50	16.54	16.83	17.64 (11)	16.68					

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: April-May 1961
STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 8a

Reach Stn. A to Stn. B	Mileage Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. Ult. BOD lb/day	Calc. Mid-Point Load lb./da.	Flowing Ult. BOD A to B lb./day	Change BOD A to B lb./day	B Calc. Ult. BOD lb./day	B Calc. Ult. BOD mg/1	B Meas. Ult. BOD lb/day	B Meas. Ult. BOD mg/1	Remarks
1 2	340.7 338.6	2.1	.102	845	31670	+240	-680	-440	31230	6.84	--	--	Existing flow +95 cfs
2 3	338.6 336.9	2.1 3.8	.069	845	31170	+3480	-500	+2980	34150	7.48	--	--	(6) (7) (8)
3 NSP	336.9 336.6	3.8 4.1	.009	845	34180	--	-50	-50	34130	7.48	--	--	--
NSP	336.6	4.1	--	340	--	--	--	--	--	--	18180 15770	10.02	(2)+290 (4)-2700
3+NSP 4	336.6 334.9	4.1 5.8	.049	1180	49900	+13540	-640	+12900	62800	9.86	--	--	
4 5	334.9 333.4	5.8 7.3	.049	1180	62700	-8630	-640	-9270	53430	8.39	--	--	(5)-700
N.Br. 6	333.4	7.3	--	100	--	--	--	--	--	--	7470	11.27	
5+6 7	333.4 331.4	7.3 9.3	.099	1280	60870 57510	-11170	-1180	-12350	45160	6.53	--	--	(1)-80 (2)-3280 (5)-3400
7 8	331.4 329.0	9.3 11.7	.230	1290	45560	+14710	-2650	+12060	57620	8.27	--	--	(5)-2500
8 9	329.0 325.8	11.7 14.9	.374	1300	58130	+5460	-4980	+480	58610	8.35	--	--	(5)-1300

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l
STREAM: UPPER ILLINOIS RIVER SYSTEM
SAMPLING PERIOD: April-May 1961

TABLE 8b

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. Ult. BOD lb/day	Calc. Mid-Point Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult. BOD lb/day	B Calc. BOD mg/l	B Meas. Ult. BOD lb/day	B Meas. BOD mg/l	Remarks
9 J.Chgo.R.	325.8 325.6	14.9 15.1	.033	1300	58550	--	-490	-490	58060	8.27	--	--	
Chgo.R.	325.6	15.1	--	645	--	--	--	--	15890	4.56	--	--	Existing flow +95 cfs added dilution
9+Chgo.R. 12	325.6 324.3	15.1 16.4	.178	1950	73940	-13280	-2630	-15910	58030	5.51	--	--	
12 13	324.3 322.8	16.4 17.9	.202	1960	58320	+4100	-2650	+1450	59770	5.65	--	--	(5)-500
13 14	322.8 320.0	17.9 20.7	.349	2010	61330	+2590	-4880	-2290	59040	5.44	--	--	(5)-5500
14 15	320.0 317.3	20.7 23.4	.314	2060	60400	+7620	-4780	+2840	63240	5.69	--	---	(5)-4900
15 WSWP	317.3 315.8	23.4 24.9	.177	2080	64020	--	-3030	-3030	60990	5.43	--	--	
WSWP	315.8	24.9	--	1250	--	--	--	--	--	--	101450 81950	15.03	(2)+4500 (3)-9990 (4)-14010
15+WSWP 16	315.8 314.0	24.9 26.7	.132	3330	142940	+63710	-6470	+57240	200180	11.13	--	--	(5)-500
16 17	314.0 307.9	26.7 32.8	.445	3380	203510 156470	+14000	-20630	-6630	149840	8.21	--	--	(1)-440 (2)-46600 (5)-700

23-a

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: April-May 1961 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 8c

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb/day	Calc. Mid-point Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult. BOD lb/day	B Calc. BOD mg/1	B Meas. Ult.BOD lb/day	B Meas. BOD mg/1	Remarks
17	307.9	32.8	.252	3420	151620	-26790	-9970	-36760					
18	304.1	36.6							114860	6.22	--	--	
18	304.1	36.6	.052	3420	114870	--	-1290	-1290					
J.Cal.Sag	303.4	37.3							113580	6.15	--	--	
Cal.Sag	303.4	37.3	--	840	--	--	--	--	--	--	30370 20670	7.59	(1),(2),(3), & (4)-9700 Existing
18+Cal.Sag	303.4	37.3	.182	4220	134250	-4540	-6840	-11380					flow + 100 cfs added dilution
19	300.5	40.2							122870	5.39	--	--	
19	300.5	40.2	.264	4160	121310	-7700	-8540	-16240					@ Cal. Sag
20	296.2	44.5							105070	4.68	--	--	
20	296.2	44.5	.285	4080	103110	+13270	-8810	+4460					
21	292.1	48.6							107570	4.88	---	--	
21	292.1	48.6	.085	4020	105940	-9080	-2610	-11690					
22	291.1	49.6							94250	4.34	--	--	
22	291.1	49.6	.073	3990	93510	--	-2160	-2160					
J.Des.Pl.	290.0	50.7							91350	4.24	--	--	

(1) Small Plant Improvements.
(2) Treatment of Known Industrial Wastes.
(3) Fee Ordinance for Industrial Wastes.
(4) Chlorination at 3 MSD Main Plants.
(5) Storm Spillage Treatment. A total of 20,000 lb/day was deducted from the existing calculated midpoint loads.
(6) All improvements were applied to April-May 1961 existing conditions.
(7) All ultimate BOD values were calculated with K_1, $20^{\circ}C. = 0.139 da^{-1}$.
(8) The value at station 1 is measured value for Apr-May '61, sampling period. All other BOD values are calculated from existing conditions of Apr-May '61, as the Model Period for this hypothesis.

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: April-May 1961 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 9a

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaer-ation A to B lb/day	Diff. Meas.(-) Calc. @ Stn B lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Rmks.
1 2	340.7 338.6	 2.1	.102	845	55120	-680	-350	+1010	-20	55100	12.08	--	--	Existing flow
2 3	338.6 336.9	2.1 3.8	.069	845	55260	-500	-220	-700	-1420	53840	11.80	--	--	+95 cfs added
3 NSP	336.9 336.6	3.8 4.1	.009	845	53840	-50	-30	--	-80	53760	11.78	--	--	dilution (1) (3)
NSP	336.6	4.1	--	340	--	--	--	--	--	--	--	14510	8.00	
3+NSP 4	336.6 334.9	4.1 5.8	.049	1180	68310	-640	+60	-1260	-1840	66470	10.43	--	--	
4 5	334.9 333.4	5.8 7.3	.049	1180	66660	-640	+90	-50	-600	66060	10.37	--	--	
N.Br., 6	333.4	7.3	--	100	--	--	--	--	--	--	--	4970	9.40	
5+6 7	333.4 331.4	7.3 9.3	.099	1280	70170	-1180	+610	-9160	-9730	60440	8.74	--	--	
7 8	331.4 329.0	9.3 11.7	.230	1290	61130	-2650	+1080	-8870	-10440	50690	7.28	--	--	
8 9	329.0 325.8	11.7 14.9	.374	1300	50580	-4980	+1960	-3600	-6620	43960	6.26	--	--	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: April-May 1961 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 9b

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaer-ation A to B lb/day	Diff. Meas. (-) Calc. @ Stn. B lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
9 J.Chgo.R.	325.8 325.6	14.9 15.1	.033	1300	43740	-490	+100	--	-390	43350	6.18	--	--	
Chgo. R.	325.6	15.1	--	645	--	--	--	--	--	--	--	35010	10.05	Existing flow +95 cfs added dilution
9+ Chgo.R. 12	325.6 324.3	15.1 16.4	.178	1950	78350	-2630	+660	+290	-1680	76670	7.28	--	--	
12 13	324.3 322.8	16.4 17.9	.202	1960	77160	-2650	+640	-3020	-5030	72130	6.82	--	--	
13 14	322.8 320.0	17.9 20.7	.349	2010	73810	-4880	+1700	+3760	+580	74390	6.85	--	--	
14 15	320.0 317.3	20.7 23.4	.314	2060	72200	-4780	+2360	+1980	-440	71760	6.45	--	--	
15 WSWP	317.3 315.8	23.4 24.9	.177	2080	65480	-3030	+1400	--	-1630	63850	5.68	--	--	
WSWP	315.8	24.9	--	1250	--	--	--	--	--	--	--	47930	7.10	
15+WSWP 16	315.8 314.0	24.9 26.7	.132	3330	111720	-6470	+2080	-1520	-5910	105810	5.88	--	--	
16 17	314.0 307.9	26.7 32.8	.445	3380	96370	-20630	+9580	-23050	-34100	62270	3.41	--	--	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: April-May 1961 TABLE 9c STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb./da.	Flowing BOD A to B lb./da.	Reaer-ation A to B lb./da	Diff. Meas.(-) Calc. @ B Sta. lb./da.	Change DO A to B lb./da.	B Calc. DO lb./da.	B Calc. DO mg/1.	B Meas. DO lb./da	B Meas. DO mg/1.	Remarks
17 18	307.9 304.1	32.8 36.6	.252	3420	62980	-9970	+3210	-2430	-9190	53790	2.91	--	--	
18 J.CalSag.	304.1 303.4	36.6 37.3	.052	3420	54850	-1290	+560	--	-730	54120	2.93	--	--	
Cal.Sag.	303.4	37.3	--	840	--	--	--	--	--	13610	3.0e	--	--	(2) Existing flow +100 cfs added dil. at Cal.Sag.
18+Cal.Sag. 19	303.4 300.5	37.3 40.2	.182	4220	67900	-6840	+2400	+5190	+750	68650	3.01	--	--	
19 20	300.5 296.2	40.2 44.5	.264	4160	67840	-8540	+3760	-200	-4980	62860	2.80	--	--	
20 21	296.2 292.1	44.5 48.6	.285	4080	63670	-8810	+5930	+6630	-3750	59920	2.72	--	--	
21 22	292.1 291.1	48.6 49.6	.085	4020	62090	-2610	+1000	+13740	+12130	74220	3.42	--	--	
22 J.Des.Pl.	291.1 290.0	49.6 50.7	.073	3990	73260	-2160	+1760	--	-400	72860	3.38	--	--	

(1) The positive meas. (+) calc. values are those of the April-May 1961 sampling period. The negative meas. (-) calc. values are those of the sampling period adjusted for flow change, i.e., multiplied by $\frac{\text{time flow hypothesis}}{\text{time flow existing}}$

(2) Cal. Sag flow estimated to provide 3.0 ppm. DO.
(3) The value at station 1 is the measured value for the April-May 1961, sampling period. All other DO values are calculated from existing conditions of April-May 1961, as the model for this hypothesis.

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l

SAMPLING PERIOD: June 1961

TABLE 10a

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No. 1	Travel Time for Reach	Flow cfs	A Meas. Ult. BOD lb./day	Calc. Midpoint Load lb./day	Flowing Ult.BOD A to B lb./day	Change BOD A to B lb./day	B Calc. Ult.BOD lb./day	B Calc. BOD mg/l	B Meas. Ult.BOD lb./day	B. Meas. BOD mg/l	Remarks
1	340.7		.095	910	27620	-1000	-640	-1640					Existing flow +50 cfs added dilution
2	338.6	2.1							25980	5.29	--	--	
2	338.6		.064	910	26000	+3700	-440	+3260					(6) (7) (8)
3	336.9	3.8							29260	5.95	--	--	
3	336.9	3.8	.011	910	29240	--	-100	-100					
NSP	336.6	4.1							29140	5.93	--	--	
NSP	336.6	4.1	--	410	--	--	--	--	--	--	23150 20010	10.53	(2)+290 (4)-3420
3+NSP	336.6	4.1	.044	1320	49150	+4500	-640	+3860					
4	334.9	5.8							53010	7.44	--	--	
4	334.9	5.8	.043	1320	53100	+4900	-640	+4260					(5)-700
5	333.4	7.3							57360	8.05	--	--	
N.Br.,6	333.4	7.3	--	40	--	--	--	--	--	--	2210	9.53	
5+6	333.4	7.3	.092	1370	59590 56230	+200	-1410	-1210					(1)-80 (2)-3280 (5)-3400
7	331.4	9.3							55020	7.44	--	--	
7	331.4	9.3	.217	1370	55120	+25000	-3920	+21080					(5)-2500
8	329.0	11.7							76200	10.30	--	--	
8	329.0	11.7	.352	1380	76680	-13200	-6780	-19980					(5)-1300
9	325.8	14.9							56700	7.61			

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: June 1961

TABLE 10b

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No. 1	Travel Time for Reach	Flow cfs	A Meas. Ult. BOD lb./day	Calc. Midpoint Load lb./day	Flowing Ult.BOD A to B lb./day	Change BOD A to B lb./day	B Calc. Ult.BOD lb./day	B. Calc. BOD mg/1	B. Meas. Ult.BOD lb./day	B. Meas. BOD mg/1	Remarks
9	325.8	14.9	.031	1380	56710	--	-520	-520					
J.Chg.R.	325.6	15.1							55650	7.47	--	--	
Chgo.R.	325.6	15.1	--	540	--	--	--	--	--	--	12770	4.38	Existing flow + 50 cfs added dilution
9+Chg.R.	325.6	15.1	.181	1920	68950	-8000	-3320	-11320					
12	324.3	16.4							57630	5.56	--	--	
12	324.3	16.4	.206	1920	57650	+7000	-3530	+3470					(5)-500
13	322.8	17.9							61120	5.90	--	--	
13	322.8	17.9	.360	1950	62130	+26500	-8110	+18390					(5)-5500
14	320.0	20.7							80520	7.65	--	--	
14	320.0	20.7	.328	1970	81490	+21100	-9250	+11850					(5)-4900
15	317.3	23.4							93340	8.77	--	--	
15	317.3	23.4	.186	1970	93400	--	-5640	-5640					
WSWP	315.8	24.9							87760	8.25	--	--	
WSWP	315.8	24.9	--	1360	--	--	--	--	--	--	171590 141890	23.40	(2)+4550 (3)-9990 (4)-24260
15+WSWP	315.8	24.9	.132	3330	229660	-61500	-8810	-70310					(5)-500
16	314.0	26.7							159350	8.86	--	--	
16	314.0	26.7	.460	3340	159800 112760	+23300	-19480	+3820					(1)-440 (2)-46600 (5)-700
17	307.9	32.8							116580	6.46	--	--	

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: June 1961

TABLE 10c

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No. 1	Travel Time for Reach	Flow cfs	A Meas. Ult. BOD lb./day	Calc. Midpoint Load lb./day	Flowing Ult.BOD A to B lb./day	Change BOD A to B lb./day	B Calc. Ult.BOD lb./day	B. Calc. BOD mg/1	B. Meas. Ult.BOD lb./day	B. Meas. BOD mg/1	Remarks
17	307.9	32.8	.257	3340	115970	+39000	-12260	+26740					
18	304.1	36.6							142710	7.91	--	--	
18	304.1	36.6	.053	3350	143090	--	-2710	-2710					
J.Cal.Sag.	303.4	37.3							140380	7.76	--	--	
Cal.Sag.	303.4	37.3	--	770	--	--	--	--	--	--	20850 11150	7.08	(1)(2)(3)&(4) -9700
18+Cal.Sag.	303.4	37.3	.187	4120	151110	-66000	-7790	-73790					Existing flow + 225 cfs added dilution at Cal. Sag.
19	300.5	40.2							77320	3.48	--	--	
19	300.5	40.2	.266	4130	77390	+35000	-8920	+26080					
20	296.2	44.5							103470	4.64	---	--	
20	296.2	44.5	.280	4140	103730	+25000	-11630	+13370					
21	292.1	48.6							117100	5.24	--	--	
21	292.1	48.6	.082	4160	117710	-7000	-3590	-10590					
22	291.1	49.6							107120	4.77	--	--	
22	291.1	49.6	.070	4160	107150	--	-2920	-2920					
J.DesPl.	290.0	50.7							104230	4.64	--	--	

(1) Small plant improvements.
(2) Treatment of known industrial wastes.
(3) Fee ordinance for industrial wastes.
(4) Chlorination at 3 MSD Main plants.
(5) Storm spillage treatment. A total of 20,000 lb./day was deducted from the existing calculated midpoint loads.
(6) All improvements were applied to June 1961 existing conditions.
(7) All ultimate BOD values were calculated with K_1, 20°C. = 0.139 da.$^{-1}$.
(8) The value at station 1 is the measured value for the June 1961, sampling period. All other BOD values are calculated from existing conditions of June 1961, as the model period for this hypothesis.

DISSOLVED OXYGEN BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: June 1961

TABLE 11a

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas DO lb/day	Flowing BOD A to B lb/day	Reaer-ation A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
1 2	340.7 338.6	 2.1	.095	910	54150	-640	-240	+560	-320	53830	10.95	--	--	Existing flow +50 cfs added dilution.
2 3	338.6 336.9	2.1 3.8	.064	910	53810	-440	-140	-1200	-1780	52030	10.59	--	--	(1) (3)
3 NSP	336.9 336.6	3.8 4.1	.011	910	52090	-100	-20	--	-120	51970	10.58	--	--	
NSP	336.6	4.1	--	410	--	--	--	--	--	--	--	16710	7.60	
3+NSP 4	336.6 334.9	4.1 5.8	.044	1320	68710	-640	+200	-2780	-3220	65490	9.19	--	--	
4 5	334.9 334.4	5.8 7.3	.043	1320	63230	-640	+260	-1530	-1910	61320	8.60	--	--	
N.Br.,6	333.4	7.3	--	40	--	--	--	--	--	--	--	1720	7.40	
5+6 7	333.4 331.4	7.3 9.3	.092	1370	62960	-1410	+1140	-13010	-13280	49680	6.72	--	--	
7 8	331.4 329.0	9.3 11.7	.217	1370	49720	-3920	+1730	-11210	-13400	36320	4.91	--	--	
8 9	329.0 325.8	11.7 14.9	.352	1380	33980	-6780	+2960	-3600	-7420	26560	3.56	--	--	

DISSOLVED OXYGEN BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

TABLE 11b

STREAM: UPPER ILLINOIS RIVER SYSTEM

SAMPLING PERIOD: June 1961

Reach Sta.A to Sta.B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A toB lb/day	Reaer-ation A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
9 .Chg.R	325.8 325.6	14.9 15.1	.031	1380	26460	-520	+140	--	-380	26080	3.50	--	--	
Chgo.R.	325.6	15.1	--	540	--	--	--	--	--	23320	8.00	--	--	Existing flow +50 cfs
9+ChgoR 12	325.6 324.3	15.1 16.4	.181	1920	49460	-3320	+750	+2660	-90	49370	4.76	--	--	added dilution.
12 13	324.3 322.8	16.4 17.9	.206	1920	48490	-3530	+910	-5370	-7990	40950	3.95	--	--	
13 14	322.8 320.0	17.9 20.7	.360	1950	41800	-8110	+2370	+11870	+6130	47930	4.55	--	--	
14 15	320.0 317.3	20.7 23.4	.328	1950	47980	-9250	+3080	+4170	-2000	45980	4.32	--	--	
15 SWP	317.3 315.8	23.4 24.9	.186	1970	41810	-5640	+1840	--	-3800	37910	3.56	--	--	
WSWP	315.8	24.9	--	1360	--	--	--	--	--	--	--	46200	6.30	
15+WSWP 16	315.8 314.0	24.9 26.7	.132	3330	84160	-8810	+2560	-570	-6820	77340	4.30	--	--	
16 7	314.0 307.9	26.7 32.8	.460	3340	70700	-19480	+10160	-3000	-12320	58380	3.24	--	--	

DISSOLVED OXYGEN BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: June 1961

TABLE 11c

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. 1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day & mg/1	Remarks
17 18	307.9 304.1	32.8 36.6	.257	3340	58260	-12260	+2850	+14060	+4650	62910	3.49	--	
18 J.Cal.Sag	304.1 303.4	36.6 37.3	.053	3350	62950	-2710	+480	--	-2230	60720	3.36	--	
Cal.Sag	303.4	37.3	--	770	--	--	--	--	--	12470	3.0e	--	(2) Existing flow +225 cfs added dilution @ Cal.Sag.
18+CalSag 19	303.4 300.5	37.3 40.2	.187	4120	72970	-7790	+2100	+2850	-2840	70130	3.15	--	
19 20	300.5 296.2	40.2 44.5	.266	4130	70470	-8920	+3340	+3880	-1700	68770	3.08	--	
20 21	296.2 292.1	44.5 48.6	.280	4140	68860	-11630	+5030	+21310	+14710	83570	3.74	--	
21 22	292.1 291.1	48.6 49.6	.082	4160	79750	-3590	+870	-5180	-7900	71850	3.20	--	
22 J.Des.Pl.	291.1 290.0	49.6 50.7	.070	4160	71890	-2920	+1700	--	-1220	70670	3.15	--	

(1) The positive meas.(-) calc. values are those of the June 1961 sampling period. The negative meas. (-) calc. values are those of the sampling period adjusted for flow change, i.e., multiplied by $\frac{\text{time flow hypothesis}}{\text{time flow existing}}$

(2) Cal. Sag. flow estimated to provide 3.0 ppm DO.

(3) The value at station 1 is the measured value for the June 1961, sampling period. All other DO values are calculated from existing conditions of June 1961, as the model for this hypothesis.

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: July 1961

TABLE 12a.

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No. 1	Travel Time for Reach	Flow cfs	A Meas. Ult. BOD lb/day	Calc. Midpoint Load lb/day	Flowing Ult. BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult. BOD lb/day	B Calc. BOD mg/1	B Meas. Ult. BOD lb/day	B Meas. BOD mg/1	Remarks
1 2	340.7 338.6	 2.1	.122	710	17680	-1770	-580	-2350	15330	4.00	--	--	Existing flow + 100 cfs added dil.
2 3	338.6 336.9	2.1 3.8	.082	710	15340	+2670	-380	+2290	17630	4.60	--	--	(6) (7) (8)
3 NSP	336.9 336.6	3.8 4.1	.014	710	17600	--	-80	-80	17520	4.57	--	--	
NSP	336.6	4.1	--	400	--	--	--	--	--	--	19480 16890	9.02	(2)+290 (4)-2890
3+NSP 4	336.6 334.9	4.1 5.8	.053	1110	34450	-9550	-480	-10030	24420	4.07	--	--	
4 5	334.9 333.4	5.8 7.3	.052	1110	24490	+4210	-420	+3790	28280	4.72	--	--	(5)-700
N.Br.,6	333.4	7.3	--	30	--	--	--	--	--	--	1840	11.36	
5+6 7	333.4 331.4	7.3 9.3	.110	1150	30370 27010	-4470	-810	-5280	21730	3.50	--	--	(1)-80 (2)-3280 (5)-3400
7 8	331.4 329.0	9.3 11.7	.256	1160	21740	+10950	-2190	+8760	30500	4.87	--	--	(5)-2500
8 9	329.0 325.8	11.7 14.9	.415	1170	30830	+4080	-4170	-90	30740	4.87	--	--	(5)-1300

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: July 1961 TABLE 12b STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta.A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb/day	Calc. Midpoint Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult.BOD lb/day	B Calc. BOD mg/1	B Meas. Ult.BOD lb/day	B Meas BOD mg/1	Remarks
9 J.Chg.R	325.8 325.6	14.9 15.1	.036	1170	30790	--	-380	-380	30410	4.81	--	--	
Chg. R.	325.6	15.1	--	1270	--	--	--	--	24410	3.56	--	--	Existing flor + 600 cfs added dil.
9+Chgo R 12	325.6 324.3	15.1 16.4	.141	2450	54800	-5290	-2250	-7540	47260	3.57	--	--	
12 13	324.3 322.8	16.4 17.9	.161	2450	46310	+2920	-2380	+540	46850	3.54	--	--	(5)-500
13 14	322.8 320.0	17.9 20.7	.284	2470	47220	+11040	-4940	+6100	53320	4.00	--	--	(5)-5500
14 15	320.0 317.3	20.7 23.4	.260	2490	53780	+5790	-5070	+720	54500	4.05	--	--	(5)-4900
15 WSWP	317.3 315.8	23.4 24.9	.147	2490	54320	--	-2960	-2960	51360	3.82	--	--	
WSWP	315.8	24.9	--	1340	--	--	--	--	--	--	100020 80720	13.78	(2)+4500 (3)-9990 (4)-13800
15+WSWP 16	315.8 314.0	24.9 26.7	.115	3840	132090	+85360	-8090	+77270	209360	10.10	--	--	(5)-500
16 17	314.0 307.9	26.7 32.8	.400	3840	212130 165090	+14510	-26540	-12030	153060	7.38	--	--	(1)-440 (2)-46600 (5)-700

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l

SAMPLING PERIOD: July 1961

TABLE 12c

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta.A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb/day	Calc. Midpoint Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult.BOD lb/day	B Calc. BOD mg/l	B Meas. Ult.BOD lb/day	B Meas. BOD mg/l	Remarks
17	307.9	32.8	.224	3840	153030	-44450	-11610	-56060					
18	304.1	36.6							96970	4.68	--	--	
18	304.1	36.6	.046	3840	96220	--	-1870	-1870					
J.Cal.Sag	303.4	37.3							94350	4.55	--	--	
Cal.Sag	303.4	37.3	--	950	--	--	--	--	--	--	22750 12780	6.74	(1),(2),(3)&(4) -9970 Existing flow
18+Cal.Sag	303.4	37.3	.160	4800	107130	+18990	-7520	+11470					
19	300.5	40.2							118600	4.58	—	—	+330 cfs added dilution @ Cal. Sag
19	300.5	40.2	.228	4810	118440	-15920	-10130	-26050					
20	296.2	44.5							92390	3.56	--	--	
20	296.2	44.5	.241	4810	92210	+38380	-1190	+27190					
21	292.1	48.6							119400	4.60	--	--	
21	292.1	48.6	.071	4820	119470	+1020	-3640	-2620					
22	291.1	49.6							116850	4.49			
22	291.1	49.6	.060	4820	116870	--	-3120	-3120					
J.DesPl.	290.0	50.7							113750	4.37	--	--	

(1) Small plant improvements.
(2) Treatment of known industrial wastes.
(3) Fee ordinance for industrial wastes.
(4) Chlorination of 3 MSD main plants.
(5) Storm spillage treatment. A total of 20,000 lb./day was deducted from the existing calculated midpoint loads.
(6) All improvements were applied to July 1961, existing conditions.
(7) All ultimate BOD values were calculated with k_1, 20°C.=0.139 da.$^{-1}$
(8) The value at station 1 is the measured value for the July 1961, sampling period. All other BOD values are calculated from existing conditions of July 1961, as the model period for this hypothesis.

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DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: JULY 1961 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 13a

Reach Sta. A to Sta. B	Mile-age Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaer-ation A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. Do lb/day	B Meas. DO mg/1	Remarks
1	340.7		.122	710	38610	-580	-140	+300	-420					Existing flow+100cfs added dilut
2	338.6	2.1								38190	9.96	--	--	
2	338.6	2.1	.082	710	38110	-380	-30	-1740	-2150					(1) (3)
3	336.9	3.8								35960	9.38	—	—	
3	336.9	3.8	.014	710	35770	-80	+10	--	-70					
NSP	336.6	4.1								35700	9.31	--	--	
NSP	336.6	4.1	--	400	--	--	--	--	--	--	--	16200	7.50	
3+NSP	336.6	4.1	.053	1110	51970	-480	+290	-3290	-3480					
4	334.9	5.8								48490	8.09	--	--	
4	334.9	5.8	.052	1110	48670	-420	+320	-3280	-3380					
5	333.4	7.3								45290	7.56	--	--	
N.BR.6	333.4	7.3	--	30	--	--	--	--	--	--	--	1100	6.76	
5+6	333.4	7.3	.110	1150	44830	-810	+1330	-6950	-6430					
7	331.4	9.3								38400	6.18	--	--	
7	331.4	9.3	.256	1160	38090	-2190	+1780	-13820	-14230					
8	329.0	11.7								23860	3.81	--	--	
8	329.0	11.7	.415	1170	23060	-4170	+3090	-4980	-6060					
9	325.8	14.9								17000	2.69	--	--	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: JULY 1961 STREAM :UPPER ILLINOIS RIVER SYSTEM

TABLE 13b

Reach Sta.A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc.@ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
9	325.8	14.9	.036	1170	16810	-380	+150	--	-230					
J.Chgo.R.	325.6	15.1								16580	2.62	--	--	
Chgo.R.	325.6	15.1	--	1270	--	--	--	--	--	50750	7.40	--	--	Existing flow +600 cfs
9+Chgo.R.	325.6	15.1	.141	2450	67340	-2250	+730	+850	-670					added dil.
12	324.3	16.4								66670	5.04	--	--	
12	324.3	16.4	.161	2450	65890	-2380	+880	-680	-2180					
13	322.8	17.9								63710	4.82	--	--	
13	322.8	17.9	.284	2470	63360	-4940	+2350	+2980	+390					
14	320.0	20.7								63750	4.79	--	--	
14	320.0	20.7	.260	2490	60240	-5070	+3200	+490	-1380					
15	317.3	23.4								58860	4.38	--	--	
15	317.3	23.4	.147	2490	55260	-2960	+1840	--	-1120					
WSWP	315.8	24.9								54140	4.03	--	--	
WSWP	315.8	24.9	--	1340	--	--	--	--	--	--	--	42820	5.90	
15+WSWP	315.8	24.9	.115	3840	96870	-8090	+2680	-9070	-14480					
16	314.0	26.7								82390	3.97	--	--	
16	314.0	26.7	.400	3840	73820	-26540	+11050	+1020	-14470					
17	307.9	32.8								59350	2.86	--	--	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: JULY 1961 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 13c

Reach Sta.A to Sta.B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc.@ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
17	307.9	32.8	.224	3840	61380	-11610	+3150	+12000	+3540					
18	304.1	36.6								64920	3.13	--	--	
18	304.1	36.6	.046	3840	64070	-1870	+530	--	-1340					
J.Cal.Sag.	303.4	37.3								62730	3.03	--	--	
Cal.Sag.	303.4	37.3	--	950	--	--	--	--	--	15390	3.0e	--	--	(2) Existing flow
18+Cal.Sag.	303.4	37.3	.160	4800	78220	-7520	+2200	+18000	+12680					+330cfs added dil. @ Cal.Sag
19	300.5	40.2								90900	3.51	--	--	
19	300.5	40.2	.228	4810	88830	-10130	+3190	+10560	+3620					
20	296.2	44.5								92450	3.56	--	--	
20	296.2	44.5	.241	4810	92990	-11190	+4650	+22250	+15710					
21	292.1	48.6								108700	4.18	--	--	
21	292.1	48.6	.071	4820	107240	-3640	+790	-320	-3170					
22	291.1	49.6								104070	4.00	--	--	
22	291.1	49.6	.060	4820	103330	-3120	+1470	--	-1650					
J.DesPl.	290.0	50.7								101686	3.91	--	--	

(1) The positive meas.(-) calc. values are those of the July 1961, sampling period. The negative meas.(-) calc. values are those of the sampling period adjusted for flow change, i.e., multiplied by $\frac{\text{time flow hypothesis}}{\text{time flow existing}}$.

(2) Cal. Sag. flow estimated to provide 3.0 ppm. DO.
(3) The value at station 1 is the measured value for the July 1961, sampling period. All other DO values are calculated from existing conditions of July 1961, as the model for this hypothesis.

BIOCHEMICAL OXYGEN DEMAND BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: August 1961 TABLE 14a STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb./day	Calc. Midpoint Load lb./day	Flowing Ult.BOD A to B lb./day	Change BOD A to B lb/day	B Calc. Ult.BOD lb./day	B. Calc. BOD mg./1.	B. Meas. Ult.BOD lb./day	B.Meas. BOD mg/1.	Remarks
1	340.7				16580								Existing flow
			.097	890		-2730	-480	-3210					+290 cfs added
2	338.6	2.1							13370	2.78	--	--	dilution
2	338.6	2.1			13460								(6)
			.065	900		+4900	-340	+4560					(7)
3	336.9	3.8							18020	3.71	--	--	(8)
3	336.9	3.8			18030								
			.011	900		--	-50	-50					
NSP	336.6	4.1							17980	3.70	--	--	
NSP	336.6	4.1	--	420	--	--	--	--	--	--	29820 25720	13.15	(2)+290 (4)-4400
3+NSP	336.6	4.1			43700								
			.044	1320		-10180	-570	-10750					
4	334.9	5.8							32950	4.62	--	--	
4	334.9	5.8			33110								(5)-700
			.043	1330		-3620	-500	-4120					
5	333.4	7.3							28990	4.04	--	--	
N.Br.,6	333.4	7.3	--	30	--	--	--	--	--	--	950	7.00	
5+6	333.4	7.3			30030								(1)-80
			.092	1370	26670	-3630	-810	-4440					(2)-3280
7	331.4	9.3							22230	3.00	--	--	(5)-3400
7	331.4	9.3			22590								(5)-2500
			.214	1390		+8130	-1950	+6180					
8	329.0	11.7							28770	3.83	--	--	
8	329.0	11.7			28960								(5)-1300
			.347	1400		-3280	-3250	-6530					
9	325.8	14.9							22430	2.97	--	--	

BIOCHEMICAL OXYGEN DEMAND BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l

SAMPLING PERIOD: August 1961 TABLE 14b STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb./day	Calc. Midpoint Load lb./day	Flowing Ult.BOD A to B lb./day	Change BOD A to B lb./day	B Calc. Ult.BOD lb./day	B Calc BOD mg./l	B Meas. Ult.BOD lb./day	B Meas. BOD mg./l.	Remarks
9 J.Chgo.R.	325.8 325.6	14.9 15.1	.030	1410	22540	--	-230	-230	22310	2.93	--	--	
Chgo. R.	325.6	15.1	--	850	--	--	--	--	11650	2.54	--	--	Existing flow +290 cfs added dilution
9+Chgo.R. 12	325.6 324.3	15.1 16.4	.152	2270	33970	-5290	-1720	-7010	26960	2.20	--	--	
12 13	324.3 322.8	16.4 17.9	.172	2290	27210	+4700	-1860	+2840	30050	2.43	--	--	(5)-500
13 14	322.8 320.0	17.9 20.7	.302	2320	30440	+15500	-4130	+11370	41810	3.34	--	--	(5)-5500
14 15	320.0 317.3	20.7 23.4	.276	2340	42330	+23650	-5560	+18090	60420	4.78	--	--	(5)-4900
15 WSWP	317.3 315.8	23.4 24.9	.157	2340	60530	--	-4040	-4040	56490	4.47	--	--	
WSWP	315.8	24.9	--	1420	--	--	--	--	--	--	97470 78550	12.73	(2)+4500 (3)-9990 (4)-13430
15+WSWP 16	315.8 314.0	24.9 26.7	.117	3760	135040	+4310	-7310	-3000	132040	6.50	--	--	(5)-500
16 17	314.0 307.9	26.7 32.8	.407	3770	132330 85300	-6210	-14050	-20260	65040	3.19	--	--	(1)-440 (2)-46600 (5)-700

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BIOCHEMICAL OXYGEN DEMAND BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l

SAMPLING PERIOD: August 1961

TABLE 14c

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb./day	Calc. Midpoint Load lb./day	Flowing Ult.BOD A to B lb./day	Change BOD A to B lb./day	B Calc. Ult.BOD lb./day	B Calc. BOD mg./l.	B Meas. Ult. BOD lb./day	B Meas. BOD mg./l	Remarks
17 18	307.9 304.1	32.8 36.6	.227	3780	64910	-9680	-5920	-15600	49310	2.42	--	--	
18 J.Cal.Sag	304.1 303.4	36.6 37.3	.047	3780	49400	--	-1020	-1020	48380	2.37	--	--	
Cal.Sag	303.4	37.3	--	1090	--	--	--	--	--	--	14430 4460	4.08	(1),(2),(3),& (4)-9970 Existing flow
18+Cal.Sag 19	303.4 300.5	37.3 40.2	.158	4870	52840	+40540	-5260	+35280	88120	3.35	--	--	+435 cfs added dilution @ Cal. Sag.
19 20	300.5 296.2	40.2 44.5	.225	4870	88100	-4160	-8680	-12840	75260	2.86	--	--	
20 21	296.2 292.1	44.5 48.6	.239	4860	75320	+19910	-8920	+10990	86310	3.29	--	--	
21 22	292.1 291.1	48.6 49.6	.070	4860	86080	+2280	-2890	-610	85470	3.26	--	--	
22 J.DesPl.	291.1 290.0	49.6 50.7	.060	4860	85290	--	-2360	-2360	82930	3.16	--	--	

(1) Small Plant improvements.
(2) Treatment of known industrial wastes.
(3) Fee ordinance for industrial wastes.
(4) Chlorination of three MSD main plants.
(5) Storm spillage treatment. A total of 20,000 lb./day was deducted from the existing calculated midpoint loads.
(6) All improvements were applied to August 1961, existing conditions.
(7) All Ultimate BOD values were calculated with K_1, 20°C, = 0.139 da.$^{-1}$
(8) The value at station 1 is the measured value for the August 1961 sampling period. All other BOD values are calculated from existing conditions of August 1961, as the model period for this hypothesis.

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: August 1961 TABLE 15a STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
1 2	340.7 338.6	 2.1	.097	890	43400	-480	+10	-430	-900	42500	8.84	--	--	Existing flow +290 cfs
2 3	338.6 336.9	2.1 3.8	.065	900	42960	-340	+60	-2130	-2410	40550	8.34	--	--	added dilution. (1) (3)
3 NSP	336.9 336.6	3.8 4.1	.011	900	40530	-50	+30	--	-20	40510	8.34	--	--	
NSP	336.6	4.1	--	420	--	--	--	--	--	--	--	15880	7.00	
3+NSP 4	336.6 334.9	4.1 5.8	.044	1320	56410	-570	+350	-2830	-3050	53360	7.49	--	--	
4 5	334.9 333.4	5.8 7.3	.043	1330	53290	-500	+410	-2680	-2770	50520	7.03	--	--	
N.Br.,6	333.4	7.3	--	30	--	--	--	--	--	--	--	970	7.16	
5+6 7	333.4 331.4	7.3 9.3	.092	1370	51600	-810	+1070	-8760	-8500	43100	5.83	--	--	
7 8	331.4 329.0	9.3 11.7	.214	1390	43760	-1950	+1450	-10600	-11100	32660	4.35	--	--	
8 9	329.0 325.8	11.7 14.9	.347	1400	31680	-3250	+2660	-5480	-6070	25610	3.39	--	--	

DISSOLVED OXYGEN BALANCE SUMMARY
WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
TABLE 15b

SAMPLING PERIOD: August 1961

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
9 J.Chg.R.	325.8 325.6	14.9 15.1	.030	1410	25810	-230	+140	--	-90	25720	3.38	--	--	Existing flow +290 cfs
Chgo.R.	325.6	15.1	--	850	--	--	--	--	--	32180	7.01	--	--	added dilution.
9+ChgoR 12	325.6 324.3	15.1 16.4	.152	2270	57910	-1720	+720	+8580	+7580	65490	5.34	--	--	
12 13	324.3 322.8	16.4 17.9	.172	2290	65170	-1860	+730	-8620	-9750	55420	4.48	--	--	
13 14	322.8 320.0	17.9 20.7	.302	2320	56130	-4130	+2270	+6280	+4420	60550	4.83	--	--	
14 15	320.0 317.3	20.7 23.4	.276	2340	58760	-5560	+2900	- 1460	-4120	54640	4.32	--	--	
15 WSWP	317.3 315.8	23.4 24.9	.157	2340	48520	-4040	+1850	--	-2190	46330	3.67	--	--	
WSWP	315.8	24.9	--	1420	--	--	--	--	--	--	--	48240	6.30	
15+WSWP 16	315.8 314.0	24.9 26.7	.117	3760	94490	-7310	+2310	-8590	-13590	80900	3.98	--	--	
16 17	314.0 307.9	26.7 32.8	.407	3770	74310	-14050	+9790	-6410	-10670	63640	3.13	--	--	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1

SAMPLING PERIOD: August 1961

TABLE 15c

STREAM: UPPER ILLINOIS RIVER SYSTEM

Reach Sta. A to Sta. B	Mileage Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc. @ B Sta. lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
17	307.9	32.8	.227	3780	63480	-5920	+2960	+1900	-1060					
18	304.1	36.6								62420	3.06	--	--	
18	304.1	36.6	.047	3780	65320	-1020	+490	--	-530					
J.CalSag	303.4	37.3								64790	3.17	--	--	
Cal.Sag	303.4	37.3	--	1090	--	--	--	--	--	17660	3.0e	--	--	(2) Existing flow + 435 cfs added dil. @ Cal.Sag
18+CalSag	303.4	37.3	.158	4870	82360	-5260	+2250	+1040	-1970					
19	300.5	40.2								80390	3.06	--	--	
19	300.5	40.2	.225	4870	74420	-8680	+3600	+7480	+2400					
20	296.2	44.5								76820	2.92	--	--	
20	296.2	44.5	.239	4860	76630	-8920	+3720	+8300	+3100					
21	292.1	48.6								79730	3.04	--	--	
21	292.1	48.6	.070	4860	77420	-2890	+960	+3530	+1600					
22	291.1	49.6								79020	3.01	--	--	
22	291.1	49.6	.060	4860	78990	-2360	+1740	--	-620					
J.DesPl.	290.0	50.7								78370	2.99	—	—	

(1) The positive meas. (-) calc. values are those of the August 1961, sampling period. The negative meas. (-) calc. values are those of the sampling period adjusted for flow change, i.e., multiplied by $\frac{\text{time flow hypothesis.}}{\text{time flow existing}}$

(2) Cal. Sag flow estimated to provide 3.0 ppm. DO.

(3) The value at station 1 is the measured value for the August 1961, sampling period. All other DO values are calculated from existing conditions of August 1961, as the model for this hypothesis.

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: January 1962
STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 16a

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb/day	Calc. Mid-point Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult.BOD lb/day	B Calc. BOD mg/1	B Meas. Ult.BOD lb/day	B Meas. BOD mg/1	Remarks
1	340.7		1.081	80	900	+290	-140	+150					Existing flow no added dilution
2	338.6	2.1							1050	2.43	--	--	
2	338.6	2.1	.684	85	1120	+1200	-150	+1050					(6) (7) (8)
3	336.9	3.8							2170	4.73	--	--	
3	336.9	3.8	.121	85	2180	--	-40	-40					
NSP	336.6	4.1							2140	4.66	--	--	
NSP	336.6	4.1	--	390	--	--	--	--	--	--	29560 25490	14.07	(2)+290 (4)-4360
3+NSP	336.6	4.1	.124	470	27630	-50	-560	-610					
4	334.9	5.8							27020	10.65	--	--	
4	334.9	5.8	.119	480	27610 --	-4110	-490	-4600					(5)-700
5	333.4	7.3							23010	8.88	--	--	
N. Br.,6	333.4	7.3	--	85	--	--	--	--	--	--	3590	7.83	
5+6	333.4	7.3	.222	570	26600 23220	-5600	-740	-6340					(1)-80 (2)-3280 (5)-3400
7	331.4	9.3							16880	5.48	--	--	
7	331.4	9.3	.513	580	17200	-3670	-1220	-4890					(5)-2500
8	329.0	11.7							12310	3.93	--	--	
8	329.0	11.7	.838	580	12280	-3210	-1250	-4460					(5)-1300
9	325.8	14.9							7820	2.50	--	--	

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: January 1962 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 16b

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb/day	Calc. Mid-point Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult.BOD lb/day	B Calc. BOD mg/1	B Meas. Ult.BOD lb/day	B Meas. BOD mg/1	Remarks
9	325.8	14.9	.072	590	7870	--	-100	-100					
J.Chgo.R.	325.6	15.1							7770	2.44	--	--	
Chgo. R.	325.6	15.1	--	135	--	--	--	--	1490	2.04	--	--	Existing flow -540 cfs
9+Chgo.R.	325.6	15.1	.475	730	9450	-1970	-510	-2480					
12	324.3	16.4							6970	1.77	--	--	
12	324.3	16.4	.541	730	6940	+1010	-950	+60					(5)-500
13	322.8	17.9							7000	1.78	--	--	
13	322.8	17.9	.949	740	7510	+1970	-1040	+930					(5)-5500
14	320.0	20.7							8440	2.11	--	--	
14	320.0	20.7	.863	750	8550	+12790	-1900	+10890					(5)-4900
15	317.3	23.4							19440	4.80	--	--	
15	317.3	23.4	.483	760	19700	--	-1560	-1560					
WSWP	315.8	24.9							18140	4.42	--	--	
WSWP	315.8	24.9	--	1260	--	--	--	--	--	--	140500 115300	20.65	(2)+4500 (3)-9990 (4)-19710
15+WSWP	315.8	24.9	.218	2020	133440	+6060	-5890	+170					(5)-500
16	314.0	26.7							133610	12.25	--	--	
16	314.0	26.7	.757	2030	134170 86470	-21190	-10410	-31600					(1)-440 (2)-46600
17	307.9	32.8							54870	5.01	--	--	(5)-700

BOD BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l
SAMPLING PERIOD: January 1962 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 16c

Reach Stn. A to Stn. B	Mile-age Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. Ult.BOD lb/day	Calc. Mid-point Load lb/day	Flowing Ult.BOD A to B lb/day	Change BOD A to B lb/day	B Calc. Ult.BOD lb/day	B Calc. BOD mg/l	B Meas. Ult. BOD lb/day	B Meas. BOD mg/l	Remarks
17 18	307.9 304.1	32.8 36.6	.423	2030	55030	-8780	-3840	-12620	42410	3.87	--	--	
18 J.Cal-Sag	304.1 303.4	36.6 37.3	.087	2030	42310	--	-660	-660	41650	3.80	--	--	
Cal-Sag	303.4	37.3	--	505	--	--	--	--	--	--	22960 12560	6.30	(1), (2), (3), & (4) -10400
18+Cal-Sag 19	303.4 300.5	37.3 40.2	.304	2535	54430	+3120	-3010	+110	54540	3.99	--	--	Existing flow -170 cfs @ Cal-Sag
19 20	300.5 296.2	40.2 44.5	.435	2520	54300	-6590	-3810	-10400	43900	3.23	--	--	
20 21	296.2 292.1	44.5 48.6	.462	2515	43730	-11230	-3120	-14350	29380	2.16	--	--	
21 22	292.1 291.1	48.6 49.6	.135	2515	29470	+2070	-680	+1390	30860	2.27	--	--	
22 J. Des Pl.	291.1 290.0	49.6 50.7	.115	2515	30830	--	-680	-680	30150	2.22	--	--	

(1) Small plant improvements
(2) Treatment of known industrial wastes
(3) Fee ordinance for industrial wastes
(4) Chlorination of 3 MSD main plants
(5) Storm spillage treatment. A total of 20,000 lb/day was deducted from the existing calculated midpoint loads.
(6) All improvements were applied to January 1962, existing conditions
(7) All ultimate BOD values were calculated with K_1 20°C. = 0.139 day^{-1}.
(8) The value at station #1 is the measured value for the January 1962, sampling period. All other BOD values are calculated from existing conditions of Jan. '61, as model period for hypothesis.

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: January 1962
STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 17a

Reach Stn. A to Stn. B	Mileage Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas. (-) Calc. @ Stn. B lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas. DO lb/day	B Meas. DO mg/1	Remarks
1 2	340.7 338.6	 2.1	1.081	80	6360	-140	+10	-170	-300	6060	14.03	--	--	Existing flow, no added ~~dilution~~ (1) (3)
2 3	338.6 336.9	2.1 3.8	.684	85	6430	-150	+80	-700	-770	5650	12.33	--	--	
3 NSP	336.9 336.6	3.8 4.1	.121	85	5700	-40	+30	--	-10	5690	12.40	--	--	
NSP	336.6	4.1	--	390	--	--	--	--	--	--	--	24330	11.58	
3+NSP 4	336.6 334.9	4.1 5.8	.124	470	30030	-560	+280	-6190	-6470	23560	9.28	--	--	
4 5	334.9 333.4	5.8 7.3	.119	480	24600	-490	+450	-1000	-1040	23560	9.09	--	--	
N. Br.,6	333.4	7.3	--	85	--	--	--	--	--	--	--	3120	6.79	
5+6 7	333.4 331.4	7.3 9.3	.222	570	26690	-740	+1470	-5080	-4350	22340	7.26	--	--	
7 8	331.4 329.0	9.3 11.7	.513	580	22080	-1220	+1510	-2860	-2570	19510	6.23	--	--	
8 9	329.0 325.8	11.7 14.9	.838	580	19320	-1250	+1790	+3070	+3610	22930	7.32	--	--	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/l
SAMPLING PERIOD: January 1962
STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 17b

Reach Stn. A to Stn. B	Mileage Index	Miles From Stn. #1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaeration A to B lb/day	Diff. Meas.(-) Calc. @ Stn. B lb/day	Change DO A to B lb/day	B Calc. DO lb/day	B Calc. DO mg/l	B Meas. DO lb/day	B Meas. DO mg/l	Remarks
9	325.8	14.9			24050									
J.Chgo.R.	325.6	15.1	.072	590		-100	+730	--	+630	24680	7.75	--	--	
Chgo.R.	325.6	15.1	--	135	--	--	--	--	--	5570	7.64	--	--	
9+Chgo.R.	325.6	15.1			29590									
12	324.3	16.4	.475	730		-510	+440	+3810	+3740	33330	8.46	--	--	Existing flow -540 cfs
12	324.3	16.4			34020									
13	322.8	17.9	.541	730		-950	+480	+2200	+1730	35750	9.07	--	--	
13	322.8	17.9			35170									
14	320.0	20.7	.949	740		-1040	+1010	+3110	+3080	38250	9.56	--	--	
14	320.0	20.7			35320									
15	317.3	23.4	.863	750		-1900	+1270	+1950	+1320	36640	9.05	--	--	
15	317.3	23.4			34230									
WSWP	315.8	24.9	.483	760		-1560	+410	--	-1150	33080	8.06	--	--	
WSWP	315.8	24.9	--	1260	--	--	--	--	--	--	--	76070	11.18	
15+WSWP	315.8	24.9			109480									
16	314.0	26.7	.218	2020		-5890	+1210	-30060	-34740	74740	6.85	--	—	
16	314.0	26.7			69610									
17	307.9	32.8	.757	2030		-10410	+7040	-6840	-10210	59400	5.42	--	—	

DO BALANCE SUMMARY WITH IMPROVEMENTS PLUS STREAM FLOWS TO MAINTAIN A DO CONCENTRATION OF 3.0 mg/1
SAMPLING PERIOD: January 1962 STREAM: UPPER ILLINOIS RIVER SYSTEM

TABLE 17c

Reach Sta. A to Sta. B	Mile-age Index	Miles from Sta. No.1	Travel Time for Reach	Flow cfs	A Meas. DO lb/day	Flowing BOD A to B lb/day	Reaer-ation A to B lb/day	Diff. Meas.(-) Calc.@ B Sta. lb/day	Change DO A tc B lb/day	B Calc. DO lb/day	B Calc. DO mg/1	B Meas DO lb/day	B Meas. DO mg/1	Remarks
17 18	307.9 304.1	32.8 36.6	.423	2030	63800	-3840	+2200	-2750	-4390	59410	5.42	--	--	
18 J.Cal.Sag.	304.1 303.4	36.6 37.3	.087	2030	54370	-660	+390	--	-270	54100	4.94	--	--	
Cal.Sag.	303.4	37.3	--	505	--	--	--	--	--	8180	3.0e	--	--	(2) Existing flow
18+Cal.Sag. 19	303.4 300.5	37.3 40.2	.304	2535	62330	-3010	+1920	-5280	-6370	55960	4.10	--	--	-170 cfs @ Cal Sag
19 20	300.5 296.2	40.2 44.5	.435	2520	51850	-3810	+2980	+10020	+9190	61040	4.49	--	--	
20 21	296.2 292.1	44.5 48.6	.462	2515	61520	-3120	+4460	-440	+900	62420	4.60	--	--	
21 22	292.1 291.1	48.6 49.6	.135	2515	63420	-680	+820	-13830	-13690	49730	3.66	--	--	
22 J.DesPl.	291.1 290.0	49.6 50.7	.115	2515	50660	-680	+1640	--	-960	49700	3.66	--	--	

(1) The positive meas. (-) calc. values are those of the January 1962, sampling period. The negative meas. (-) calc. values are those of the sampling period adjusted for flow change, i.e., multiplied by $\frac{\text{time flow hypothesis}}{\text{time flow existing}}$.

(2) Cal. Sag flow estimated to provide 3.0 ppm. DO.

(3) The value at station 1 is the measured value for the January 1962, sampling period. All other DO values are calculated from existing conditions of January 1962, as the model for this period.

TABLE 18

ESTIMATED SOURCES BIOCHEMICAL OXYGEN DEMAND LOADS

With Improvements Plus Stream Flows to Maintain a DO Concentration of 3.0 mg/1 DO
Ultimate BOD in pounds per day

Source	April-May 1961	June 1961	July 1961	August 1961	January 1962	Averages (5 periods)
Station No. 1	31670	27620	17680	16580	900	18890
NSSTP	15770	20010	16890	25720	25490	20780
N.R.N.Br.Chgo.R.	7390	2130	1760	870	3510	3130
Chicago River	15890	12770	24410	11650	1490	13240
S-SWSTP	81950	141890	80720	78550	115300	99680
Cal-Sag Channel (39)	20670	20850	12780	4460	12780	14310
Totals	173,340	225,270	154,240	137,830	159,470	170,030

TABLE 19a

ESTIMATED ANNUAL AVERAGE DILUTION REQUIREMENTS FOR ALKYL BENZENE SULFONATE (ABS)
UPPER ILLINOIS RIVER SYSTEM - MAINSTEM
ABS OBJECTIVE 0.5 mg/l AT DRESDEN DAM, STATION 27 (IR 271.6)

Condition	Flow @ Station 27 cfs	Estimated ABS @ Stn. 27		Est. Added Dilution Req'd. cfs	Est. Total Flow @ Stn. 27 cfs	Annual Flow Lockport Stn. 22 cfs	Est. Total Flow @ Stn. 22 cfs
		mg/l	lb/da.				
* I - Existing '61	8025	0.77	33370	4330	12357	3411	7743
II - Existing **Plus** Imprvmts.	8025	0.77	33370	4330	12357	3411	7743
III - Est. 1980	8445	0.87	39675	6250	14693	4180	10428
IV - Existing '61 w/storm spillage control	8025	0.77	33370	4330	12357	3411	7743
V - Est. 1980 w/storm spillage control	8445	0.87	39675	6250	14693	4180	10428

*Footnotes are in Table 35b.

TABLE 19b

DILUTION CALCULATIONS FOR 0.5 mg/l ABS AT DRESDEN DAM STATION 27 (IR 271.6)

Calculations for Conditions I, II, IV:

$$\begin{aligned} 0.77 \times 8025 \times 5.4 &= 0.50(8025 + X)\ 5.4 \\ 6179 &= 4013 + 0.5X \\ 0.5X &= 2166 \\ X &= 4332 \text{ cfs} \end{aligned}$$

Calculations for Conditions III and IV:

$$\begin{aligned} 0.87 \times 8445 \times 5.4 &= 0.50(8445 + X)\ 5.4 \\ 7347 &= 4223 + 0.50X \\ 0.5X &= 3124 \\ X &= 6248 \text{ cfs} \end{aligned}$$

*I - ABS determined by tests from three treatment plants in September 1961. These values were increased 25% to account for storm overflow and these values were then assumed to be the average values for the year Estimated average flows from the yearly average at Lockport were used to calculate concentrations.

II - Proposed improvements were estimated not to have any appreciable effect on ABS levels.

III - Based on condition I with all ABS loadings increased 20% except Kankakee basin which was increased 15% Twenty per cent is the projected increase of ABS consumption based on detergent and population statistics. The Kankakee basin was increased 15% instead of 20% because of anticipated treatment improvements.

IV&V - These are hypothetical conditions regarding retention and chlorination of storm spillage. They are assumed equivalent to conditions II and III, respectively, regarding ABS. All conditions represent the estimated ABS concentrations for the corresponding conditions for which the BOD and DO concentrations were estimated.

TABLE 20a
UPPFR ILLINOIS RIVER SYSTEM - MAINSTEM
ALKYL BENZENE SULFONATE (ABS)

	Sept. '61 Plant Measurements		Sept. '61 Adjusted for Storm Overflow		Estimated Yearly Average for 1961		January '62 Stream Measurements	
Station	Flow cfs	ABS mg/l lb/day	Flow cfs	ABS mg/l lb/day	Flow cfs	ABS mg/l lb/day	Flow cfs	ABS mg/l lb/day
NSSTP	520	1.5 4195	520	-- 5245	395	-- 5245	--	--
SWSTP	1725	1.5 13975	1725	-- 17465	1350	-- 17465	--	--
Cal. STP	285	1.8 2770	285	-- 3465	215	-- 3465	--	--
TOTAL	2530	-- 20940	2530	-- 26175	1965	-- 26175	--	--
19 SS 300.5	4900	0.79 20940	4900	0.99 26175	3400	1.43 26175	3200	1.49 25680
22 SS 291.1	5000	0.78 20940	5000	0.97 26175	3410	1.42 26175	3200	1.24 21375
22½ SS 290.0	5000	0.70	5000	0.87	3410	1.28 23560	--	--
Above Dam & 10% Deducted.		18845		23560				
(Des Plaines R.)	(3000)	0.55 (8910)	(3000)	(0.55) (8910)	(175)	(6.42) (6000)	(275)	(0.81) (1195)
25 DP 278.0	8500	0.60 27755	8500	0.71 32470	3595	1.53 29555	3870	1.19 24930

TABLE 20b
UPPER ILLINOIS RIVER SYSTEM - MAINSTEM
ALKYL BENZENE SULFONATE (ABS)

Station	Sept. '61 Plant Measurements		Sept. '61 Adjusted for Storm Overflow		Estimated Yearly Average for 1961		January '62 Stream Measurements	
	Flow cfs	ABS mg/l lb/da.	Flow cfs	ABS mg/l lb/da.	Flow cfs	ABS mg/l lb/da.	Flow cfs	ABS mg/l lb/da.
(Du Page R.)	(940)	(0.11) (560)	(940)	(0.11) (560)	(255)	(0.40) (560)	--	--
(Kankakee R.)	(3560)	(0.35) (6730)	(3560)	(0.35) (6730)	(4160)	(0.30) (6730)	(4030)	(0.34) (7465)
Kankakee plus Mainstem	13000	0.50 35040	13000	0.57 39755	8010	0.85 36865	--	--
I.R. 271.6 Control Point Above Dam & 10% Deducted	13000	0.45 31540	13000	0.51 35780	8025	0.77 33175	8030	0.44 19165

DILUTIONS CALCULATIONS FOR 0.5 mg/l ABS AT DRESDEN DAM (I.R. 271.6)

Calculations for Conditions I, II, IV:

$$0.77 \times 8025 \times 5.4 = 0.50(8025 + X)\,5.4$$
$$6179 = 4013 + 0.5X$$
$$0.5X = 2166$$
$$X = 4332 \text{ cfs}$$

*I-ABS determined by tests from three treatment plants in September 1961. These values were increased 25% to account for storm overflow and these values were then assumed to be the average values for the year. Estimated average flows from the yearly average at Lockport were used to calculate concentrations.

II - Proposed improvements were estimated not to have any appreciable effect on ABS levels.

TABLE 21a
ESTIMATED EFFECTS OF CHLORINATION OF ALL SEWAGE (4) AND METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO (MSD) EFFLUENTS (5) ON COLIFORM DENSITIES IN UIRS

Sampling Point or Tributary Inflow	Average Flow cfs	Coliform Density per 100 ml		Estimated Coliform Density per 100 ml Assuming Treatment & Chlorination	
		4-month Geometric Mean	Calculated	of All Sewage	of MSD Plant Effluents
(1)		(2)	(3)	(4)	(5)
North Shore Channel and North Branch Chicago River					
NS 340.7*	700	(200)		(200)	(200)
NS 338.6*	706	(3,500)		(3,500)	(3,500)
NS 336.9*	710	(8,200)		(8,200)	(8,200)
MSD-NSSTP[a]	391	440,000		4,400***	4,400***
NS 334.9	1,110	160,000	160,000	6,800	6,800
NS 333.4	1,114	140,000		6,000	6,000
NB 333.4*	48	(71,000)		(71,000)	(71,000)
NB 331.4	1,177	160,000	140,000	10,000	29,000
NB 329.0	1,182	220,000		14,000	89,000
NB 325.8	1,194	390,000		25,000	260,000
South Branch, Chicago River, and Sanitary and Ship Canal					
CH 326.9*	566	(680)		(680)	(680)
CH 325.8*	569	(9,100)		(9,100)	(9,100)
SB 324.3	1,770	200,000	270,000	15,000	130,000
SB 322.8	1,787	280,000		21,000	210,000
SS 320.0	1,832	260,000		20,000	200,000
SS 317.3	1,848	230,000		18,000	180,000
MSD-WSW[b]	1,392	(680,000)		6,800***	6,800***
SS 314.0	3,176	420,000	430,000	13,000	110,000
SS 307.9	3,215	460,000		14,000	150,000
SS 304.1**	3,218	270,000		8,200	88,000
CS 304.1**	641	23,000		5,900	12,000

TABLE 21b

Sampling Point or Tributary Inflow (1)	Average Flow cfs	Coliform Density per 100 ml 4-Month Geometric Mean (2)	Coliform Density per 100 ml Calculated (3)	Estimated Coliform Density per 100 ml Assuming Chlorination (4)	Estimated Coliform Density per 100 ml Assuming Chlorination (5)
South Branch, Chicago River, and Sanitary and Ship Canal (Continued)					
SS 300.5	3,847	200,000	230,000	6,800	67,000
SS 296.2	3,836	110,000		3,700	37,000
SS 292.1	3,819	61,000		2,100	18,000
SS 291.1	3,808	72,000		2,500	29,000
Des Plaines River					
DP 292.7*	290	(4,200)		(4,200)	(4,200)
DP 285.8	4,158	79,000	67,000	3,100	39,000
DP 278.0	4,175	64,000		2,500	32,000
Kankakee River					
KR 277.5*	4,017	(20,000)		(20,000)	(20,000)
Illinois River					
IR 271.5	8,344	17,000	42,000	4,600	11,000
Calumet River and Cal-Sag Channel					
CA 332.7*	275	(2,000)		(2,000)	(2,000)
CA 328.1*	281	(5,400)		(5,400)	(5,400)
GC 325.8*	9	(2,300,000)		(2,300,000)	(2,300,000)
CA 327.0*	282	(4,000)		(4,000)	(4,000)
LC 322.4*	293	(40,000)		(40,000)	(40,000)
LC 320.2*	183	(150,000)		(150,000)	(150,000)
LC 320.1	434	(51,000)		(51,000)	(51,000)
MSD-Cal^c	227	300,000		3,000***	3,000***
CS 317.9	583	120,000	140,000	30,000	30,000
CS 314.9	603	190,000		48,000	100,000

TABLE **21c**

Sampling Point or Tributary Inflow (1)	Average Flow cfs	Coliform Density per 100 ml 4-Month Geometric Mean (2)	Coliform Density per 100 ml Calculated (3)	Estimated Coliform Density per 100 ml Assuming Chlorination (4)	Estimated Coliform Density per 100 ml Assuming Chlorination (5)
Calumet River and Cal-Sag Channel (continued)					
CS 311.5	618	110,000		28,000	58,000
CS 308.5	623	98,000		25,000	52,000
CS 304.1	641	23,000		5,900	12,000
Illinois River[d]					
IR 271.6	6,620	28,000			
IR 270.6	6,620	27,000			
IR 263.5	6,770	32,000			

* These points, either upstream from MSD discharges or located on tributaries, are not affected by these discharges.

** Indicates junction of Calumet-Sag Channel, and Sanitary and Ship Canal.

*** Present MSD effluent reduced by 99 per cent.

a. MSD Northside Sewage Treatment Plant Effluent.
b. MSD West-Southwest Sewage Treatment Plant Effluent.
c. MSD Calumet Sewage Treatment Plant Effluent.
d. July 1962 data.

TABLE 22

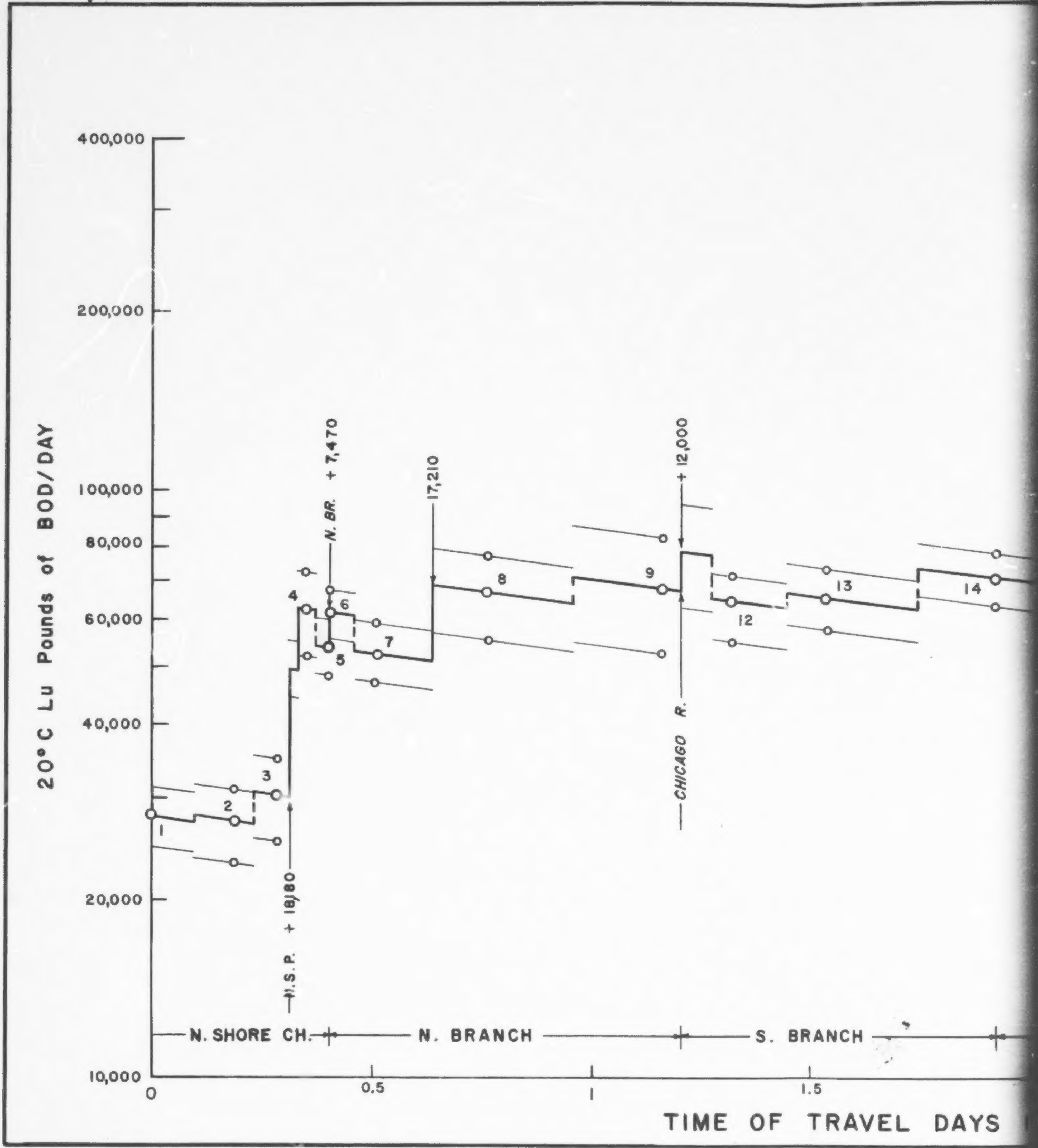
UPPER ILLINOIS RIVER SYSTEM

HYDRAULICS FOR FIVE MODEL STUDY PERIODS--EXISTING AND IMPROVED CONDITIONS

STATION	April-May, 1961		June 1961		July 1961		August 1961		January 1962(1)	
	Existing Flow, cfs	Condition IV/Change in Flow Flow, cfs	Existing Flow, cfs	Condition IV/Change in Flow Flow, cfs	Existing Flow, cfs	Condition IV/Change in Flow Flow, cfs	Existing Flow, cfs	Condition IV/Change in Flow Flow, cfs	Ex-is-ting Flow cfs	Condi-tion IV Chg.in Flow Flow cfs
Wilmette Station 1.(NS340.7)	750	+95 845	860	+50 910	605	+100 705	590	+290 880	80	0 80
North Shore Sanitary T.P.	340	0 340	410	0 410	400	0 400	420	0 420	390	0 390
Chicago River Station 10 (CH326.9)	550	+95 645	490	+50 540	670	600 1270	565	+290 855	670	-540 130
West Southwest Sanitary T.P.	1250	0 1250	1360	0 1360	1345	0 1345	1420	0 1420	1260	0 1260
Calumet-Sag Channel, Station 39 (CS304.1)	740	+100 840	545	225 770	625	+330 955	655	+435 1090	675	-170 505
Lockport Station 22 (SS291.1)	3800	+290 4090	3805	+325 4130	3790	+1030 4820	3840	+1015 4855	3200	-710 2490

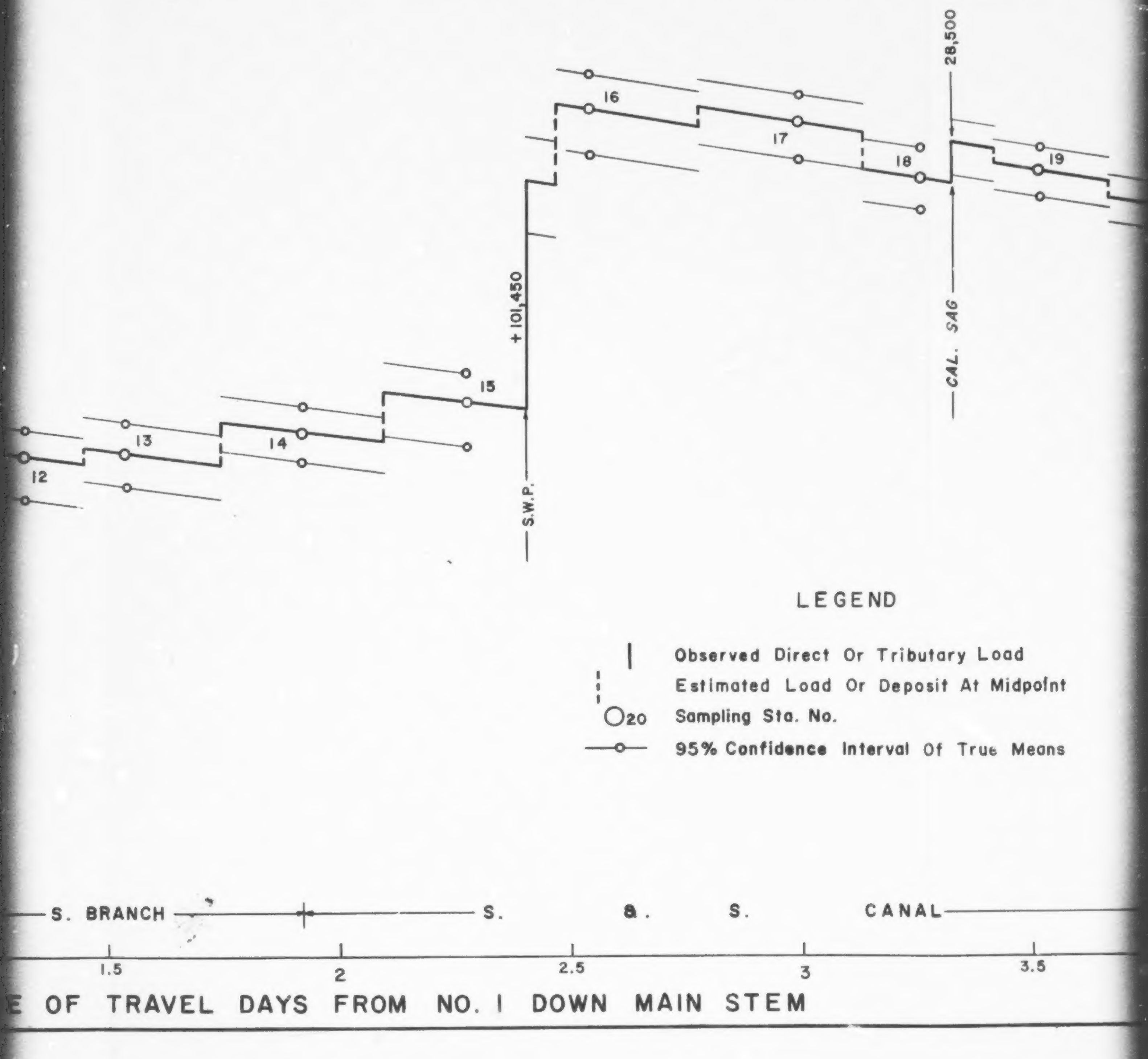
(1) According to the model month at January, the estimated decrease in needed flow would have resulted in a large increase in flow time causing septic conditions in the Chicago River because of bottom sludge effects. Since this was considered unlikely, the bottom effects for the hypothesis were considered the same as those of the existing conditions. This resulted in a calculated minimum DO of 3.73 mg/l in the mainstem with more than adequate dilution water.

A

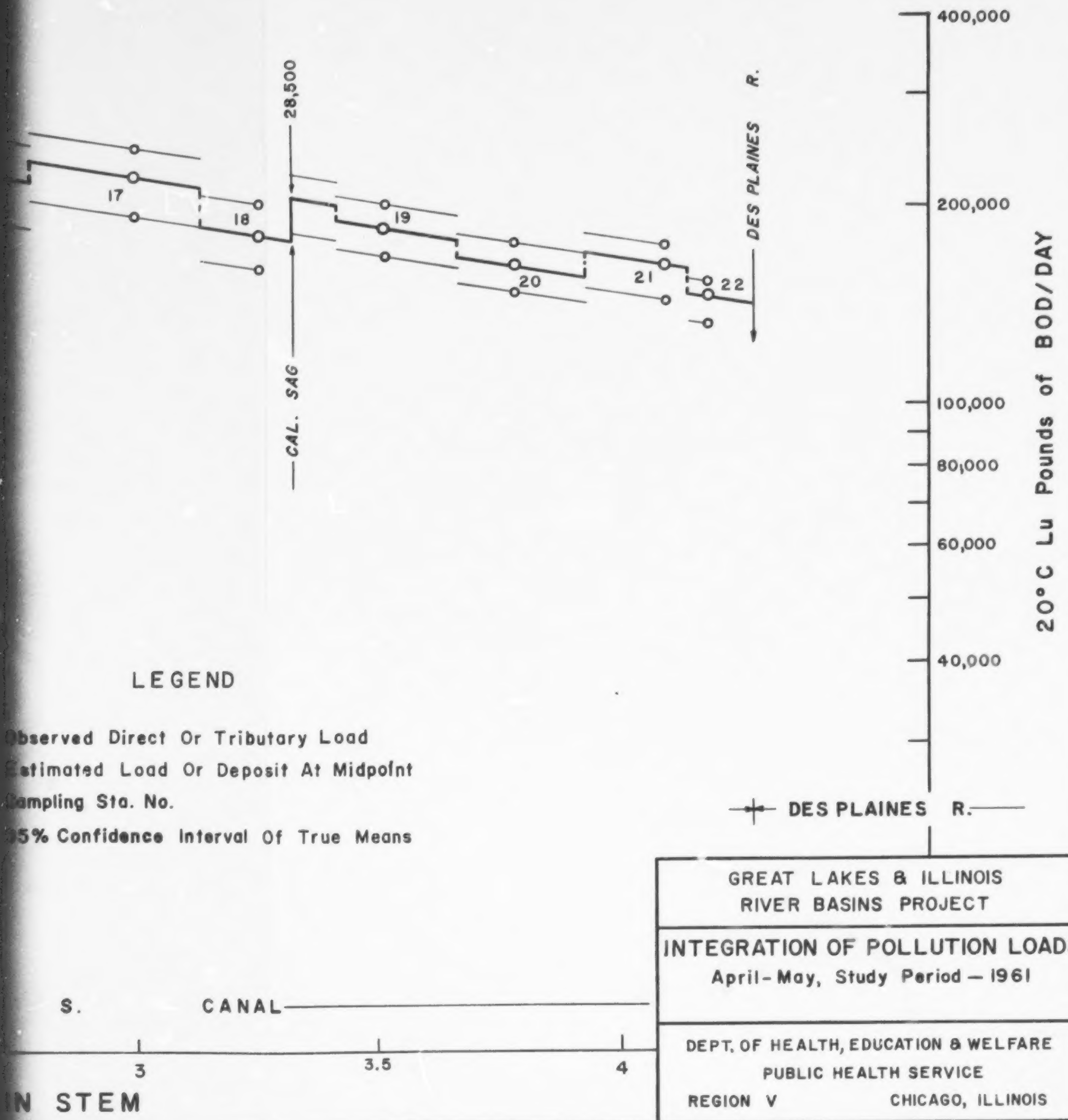


20° C Lu Pounds of BOD/DAY
400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
0
0.5
1
1.5
TIME OF TRAVEL DAYS
1
2
3
4
5
6
7
8
9
12
13
14
N.S.P. + 18,180
N. BR. + 7,470
17,210
+ 12,000
CHICAGO R.
N. SHORE CH.
N. BRANCH
S. BRANCH

B


28,500
16
17
18
19
+101,450
CAL. SAG
15
13
14
12
S.W.P.
LEGEND
Observed Direct Or Tributary Load
Estimated Load Or Deposit At Midpoint
○20 Sampling Sta. No.
95% Confidence Interval Of True Means
S. BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
E OF TRAVEL DAYS FROM NO. I DOWN MAIN STEM

C



GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

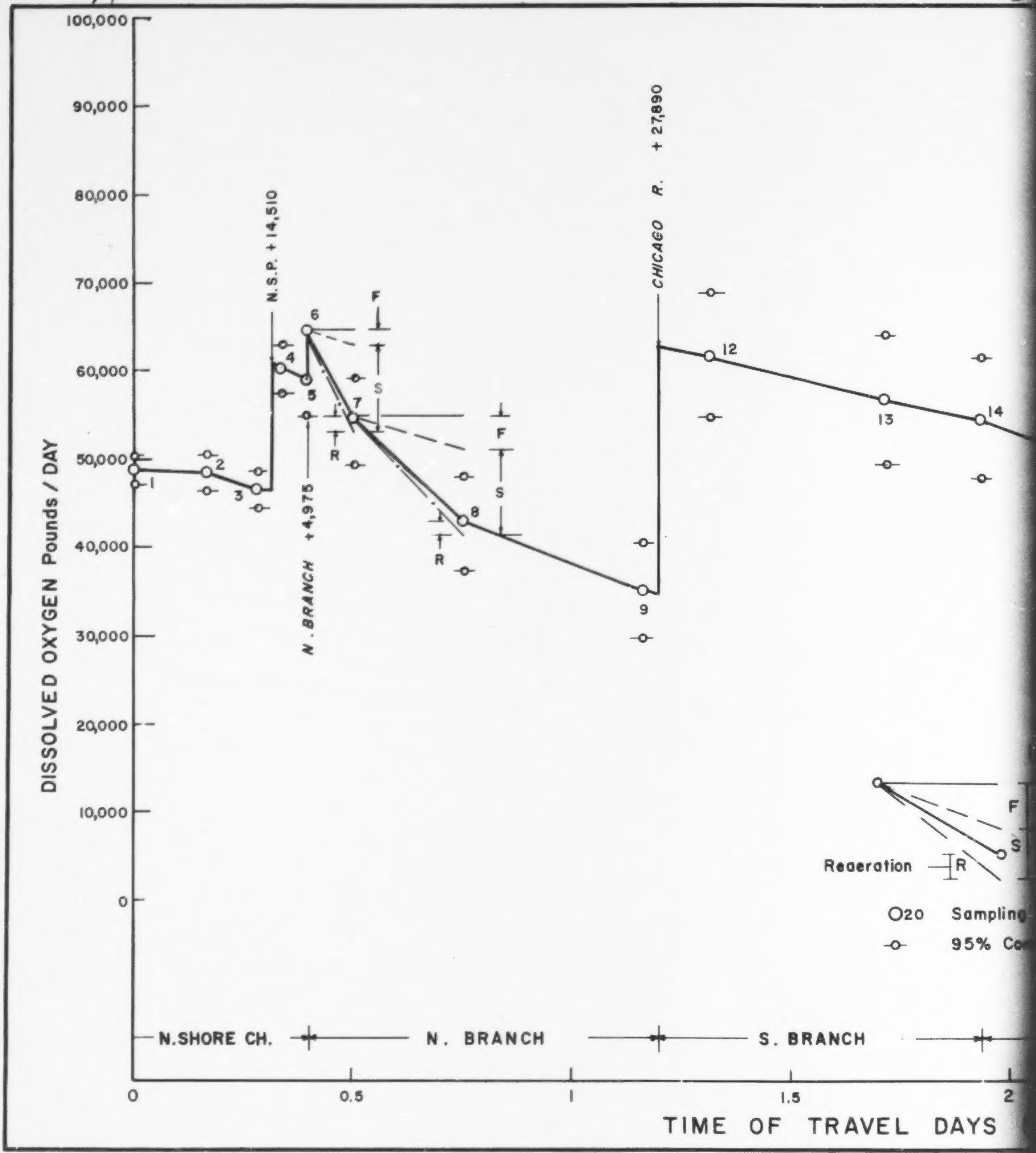
INTEGRATION OF POLLUTION LOADS
April-May, Study Period — 1961

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

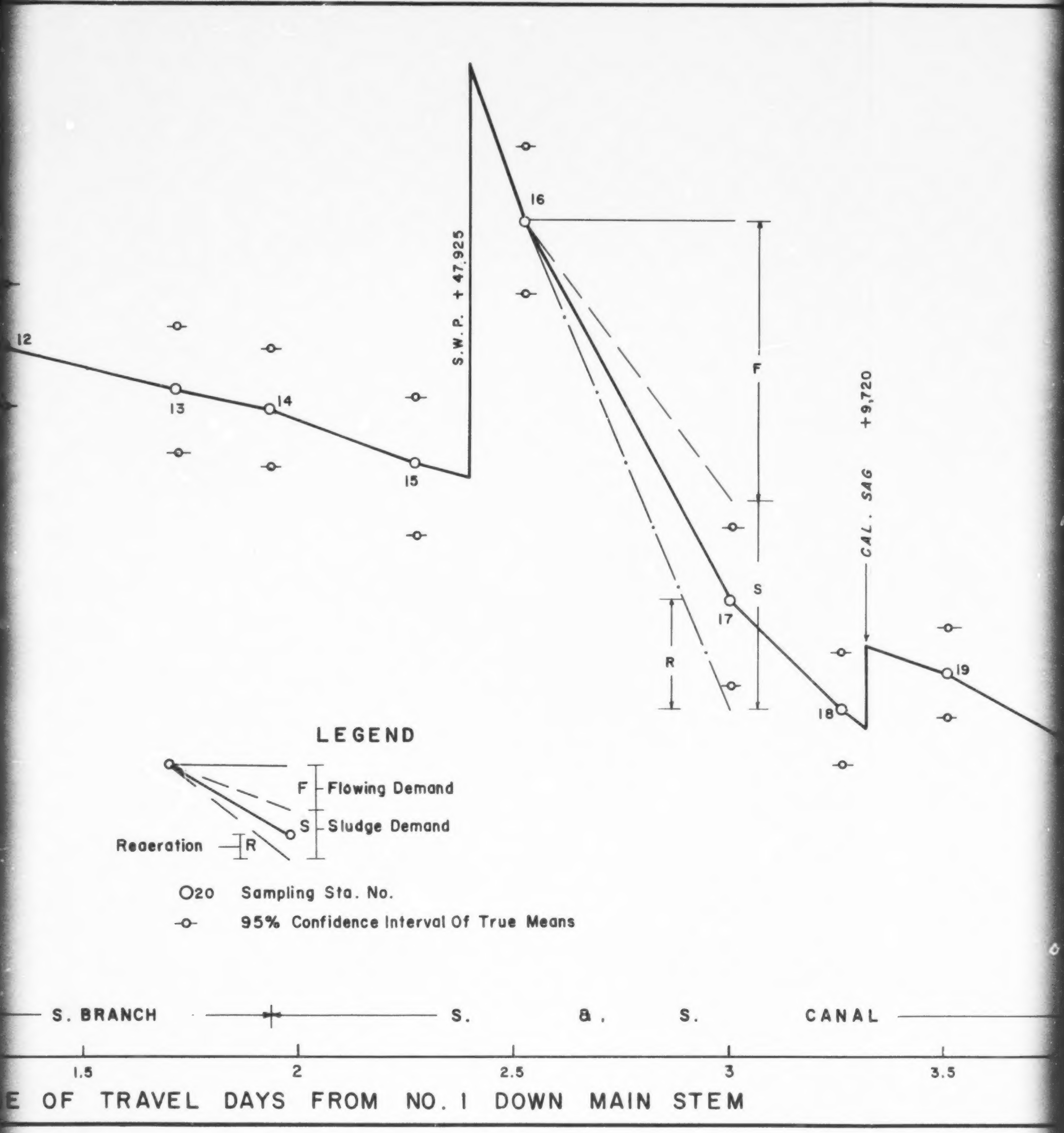
FIGURE 1

A

B

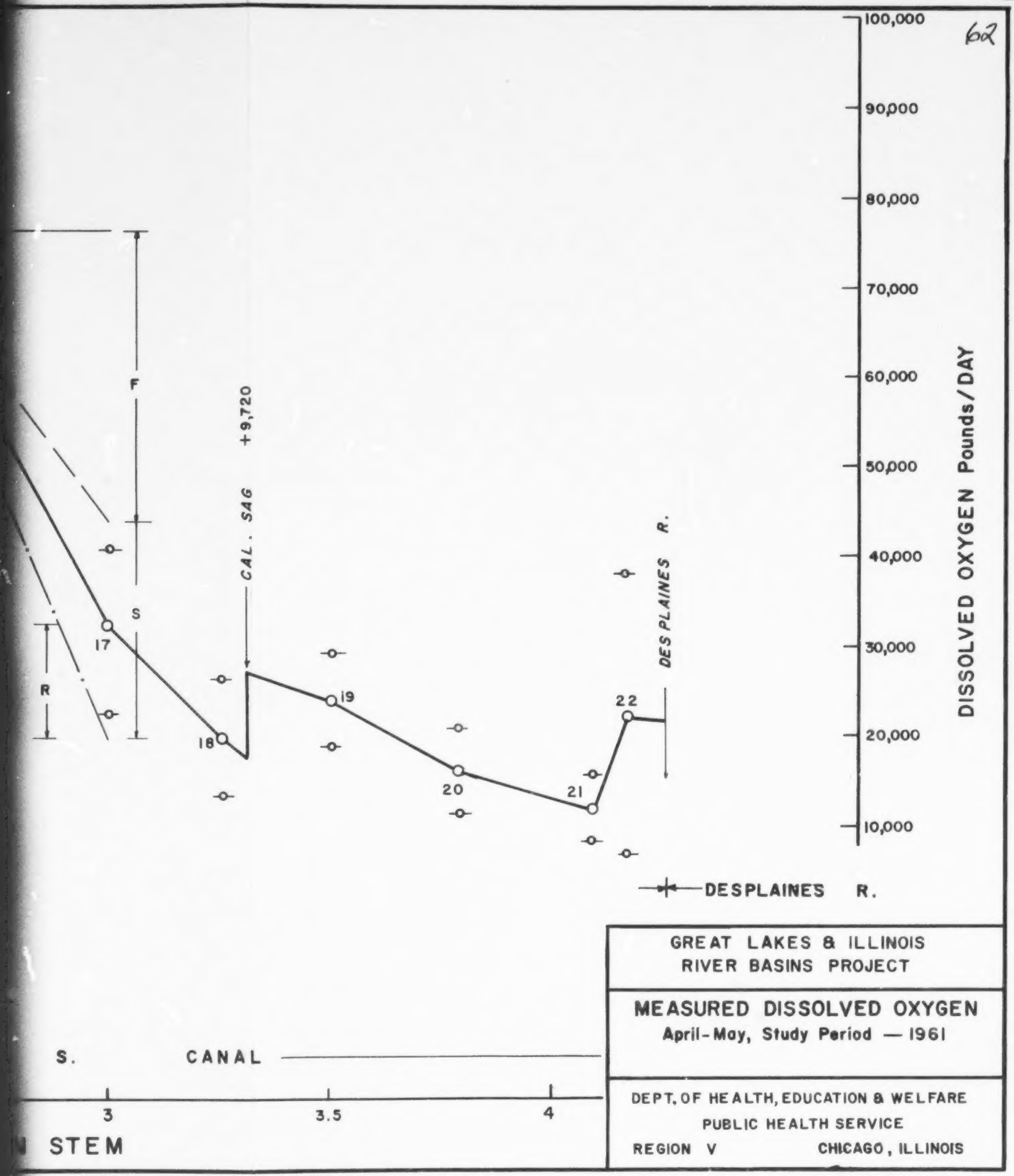

DISSOLVED OXYGEN Pounds / DAY
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
N.S.P. + 14,510
N. BRANCH + 4,975
CHICAGO R. + 27,890
1
2
3
4
5
6
7
8
9
12
13
14
F
S
R
F
S
R
F
S
Reaeration
R
O20 Sampling
95% Co
N.SHORE CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS

B


12
13
14
15
S.W.P. + 47,925
16
F
S
R
17
18
CAL. SAG +9,720
19
LEGEND
F - Flowing Demand
S - Sludge Demand
Reaeration R
○20 Sampling Sta. No.
-o- 95% Confidence Interval Of True Means
S. BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
E OF TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

C

62



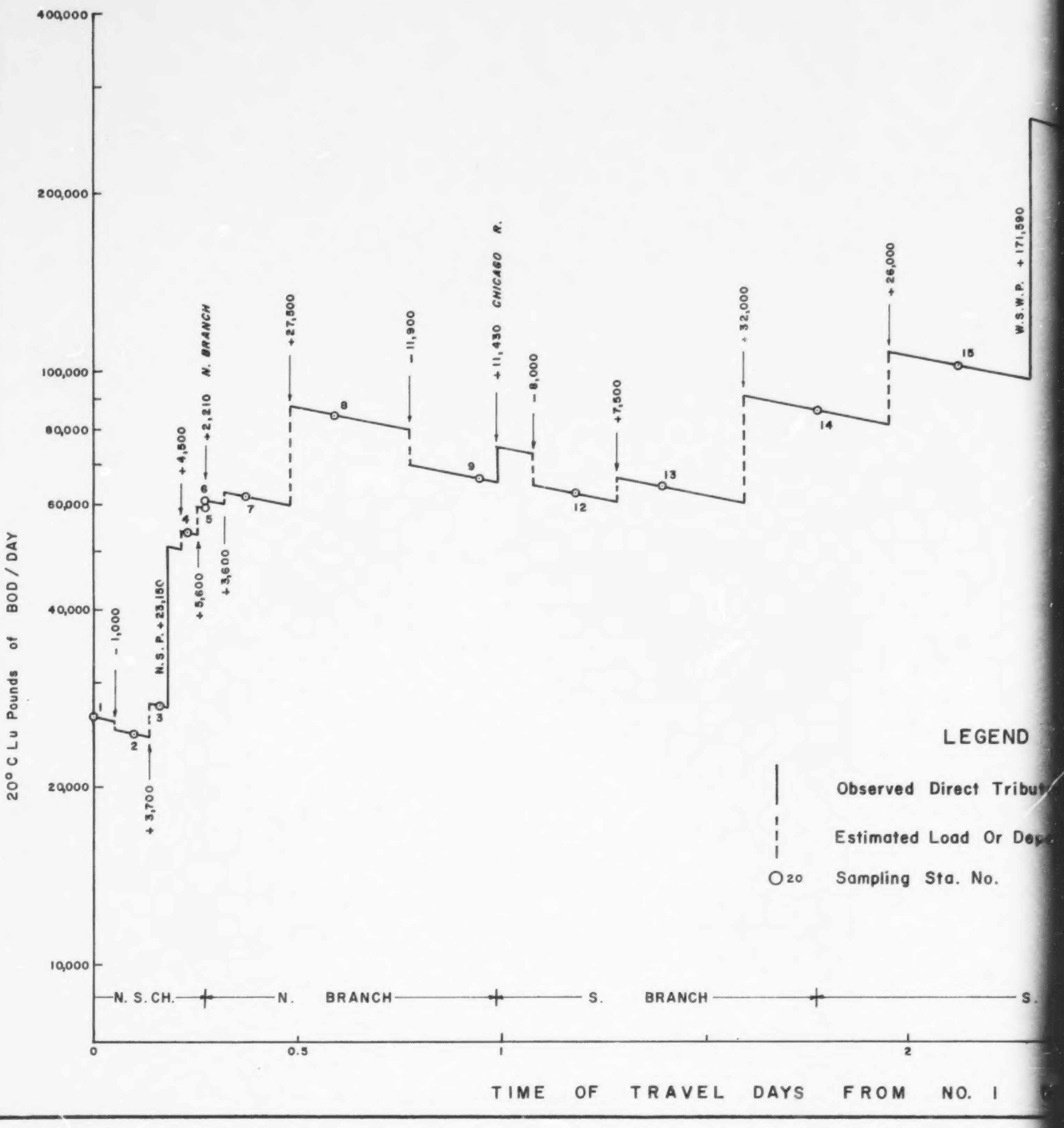
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

MEASURED DISSOLVED OXYGEN
April-May, Study Period — 1961

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

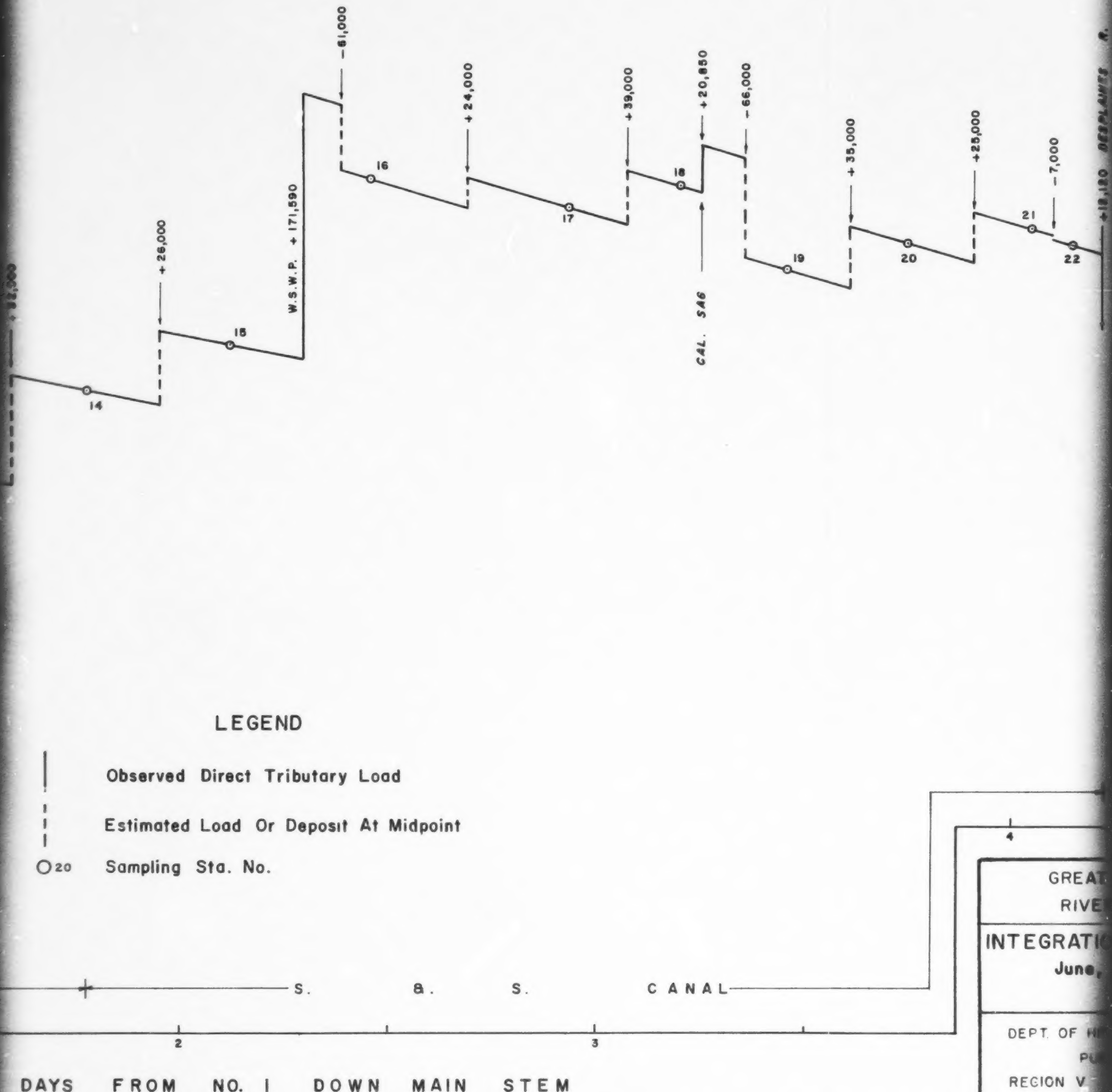
FIGURE 2

A



400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
20° C Lu Pounds of BOD / DAY
1
2
3
4
5
6
7
8
9
12
13
14
15
- 1,000
+ 3,700
N. S. P. + 23,150
+ 4,500
+ 5,600
+ 2,210
N. BRANCH
+ 3,600
+ 27,500
- 11,900
+ 11,430 CHICAGO R.
- 8,000
+ 7,500
+ 32,000
+ 26,000
W. S. W. P. + 171,590
N. S. CH.
N. BRANCH
S. BRANCH
S.
0
0.5
1
2
TIME OF TRAVEL DAYS FROM NO. 1
LEGEND
Observed Direct Tribut
Estimated Load Or Dep
20 Sampling Sta. No.

B

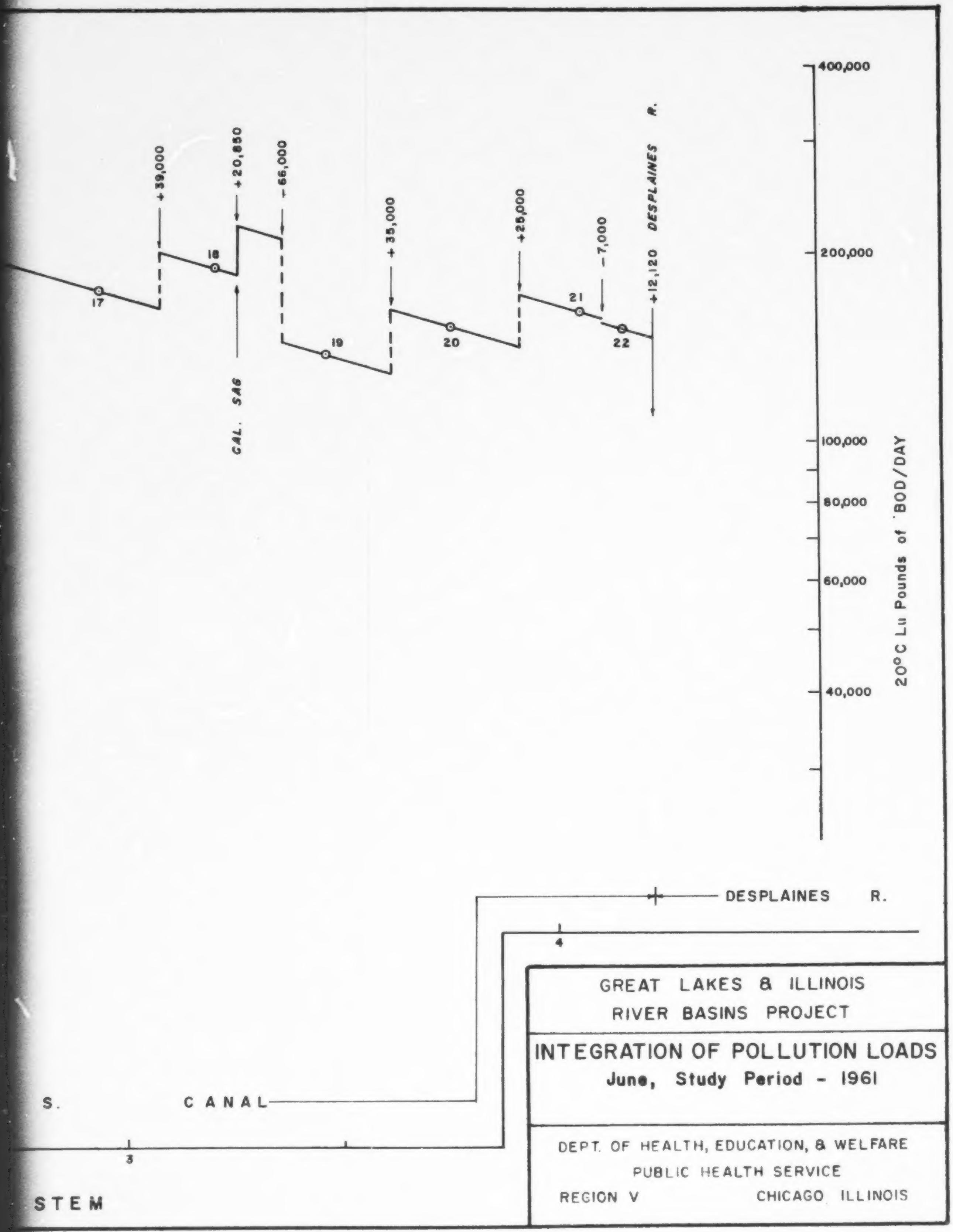


GREAT
RIVE

INTEGRATIO
June,

DEPT. OF H
PU
REGION V

C 63



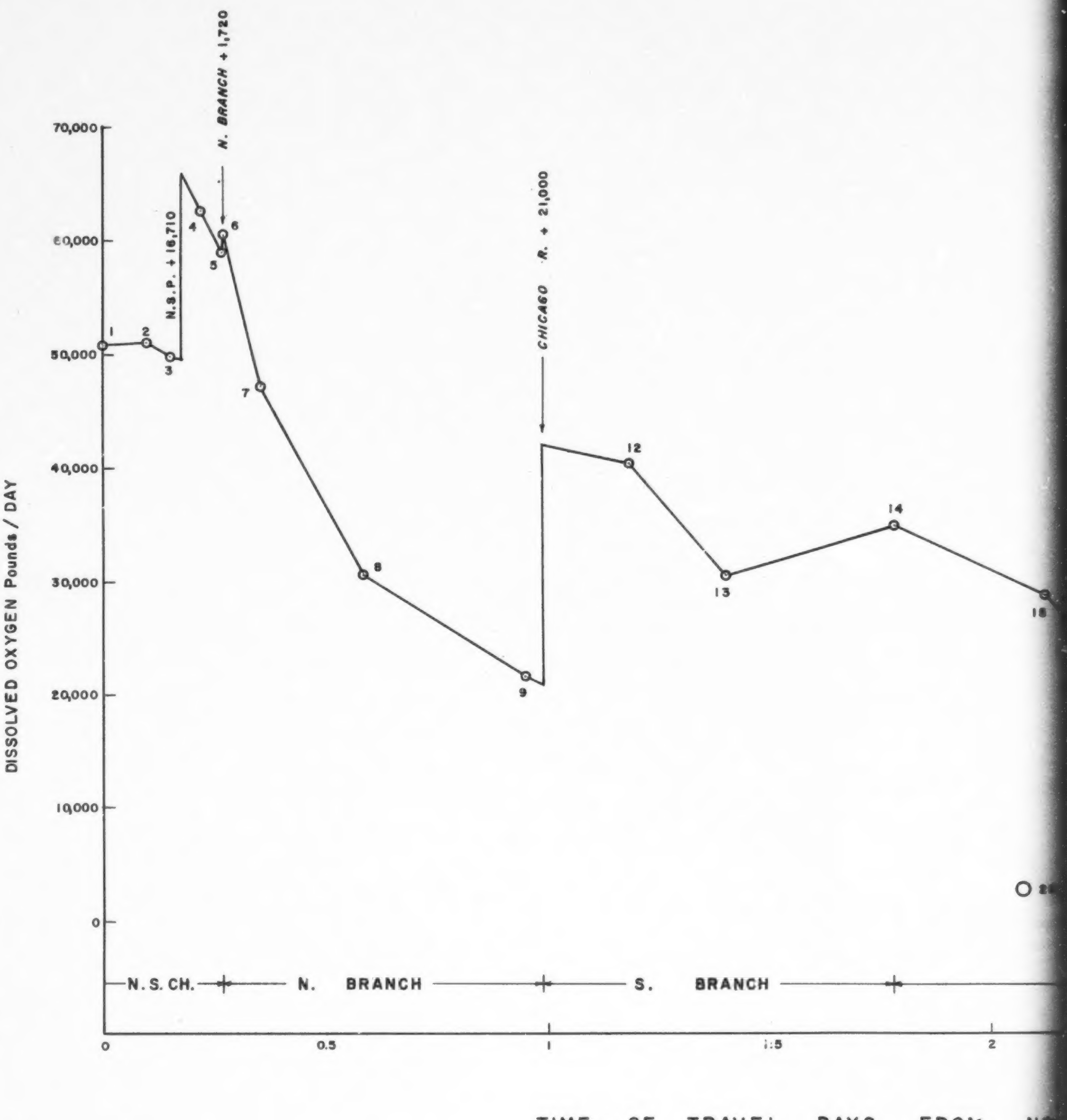
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
June, Study Period - 1961

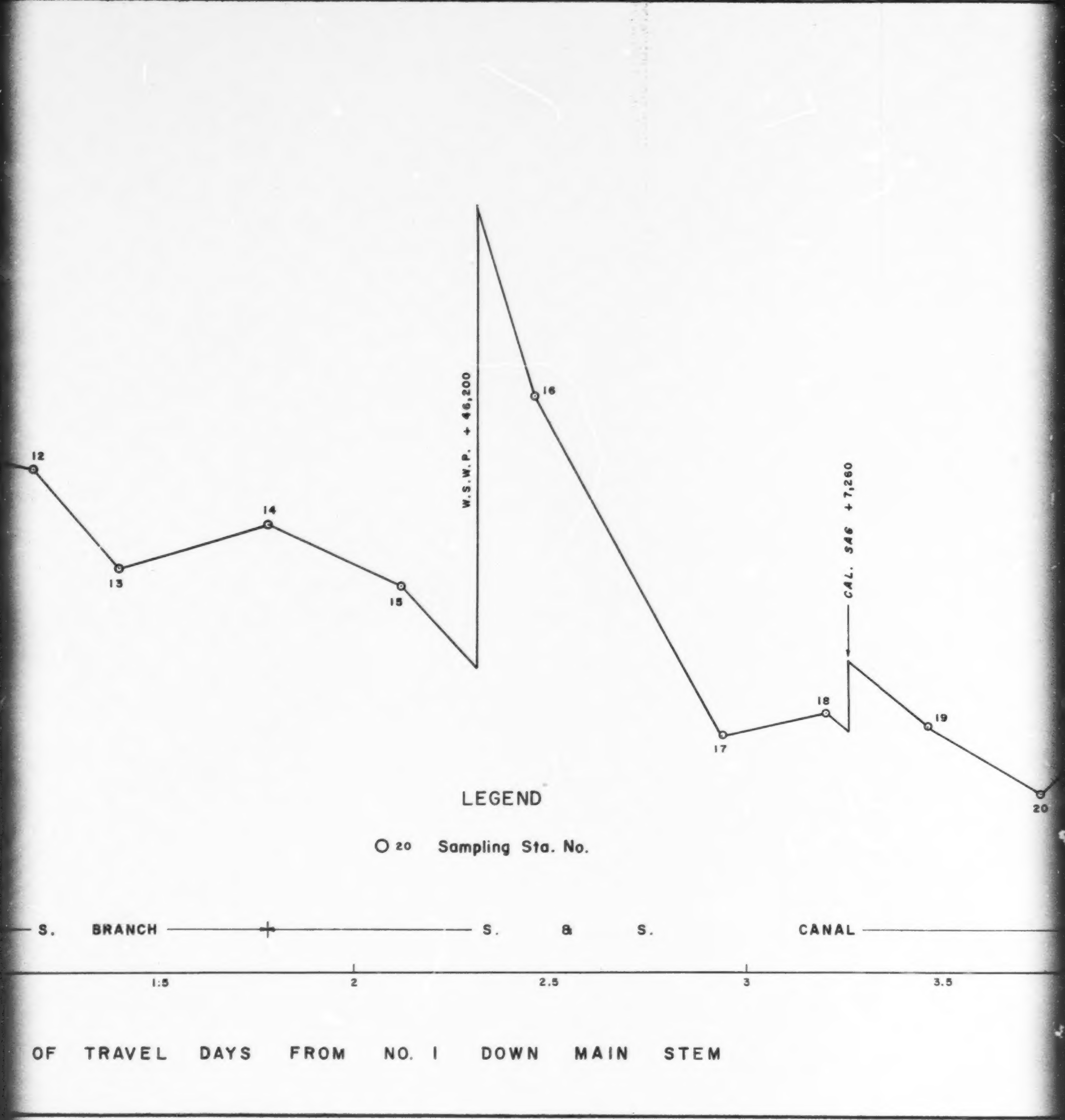
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO ILLINOIS

FIGURE 3

A

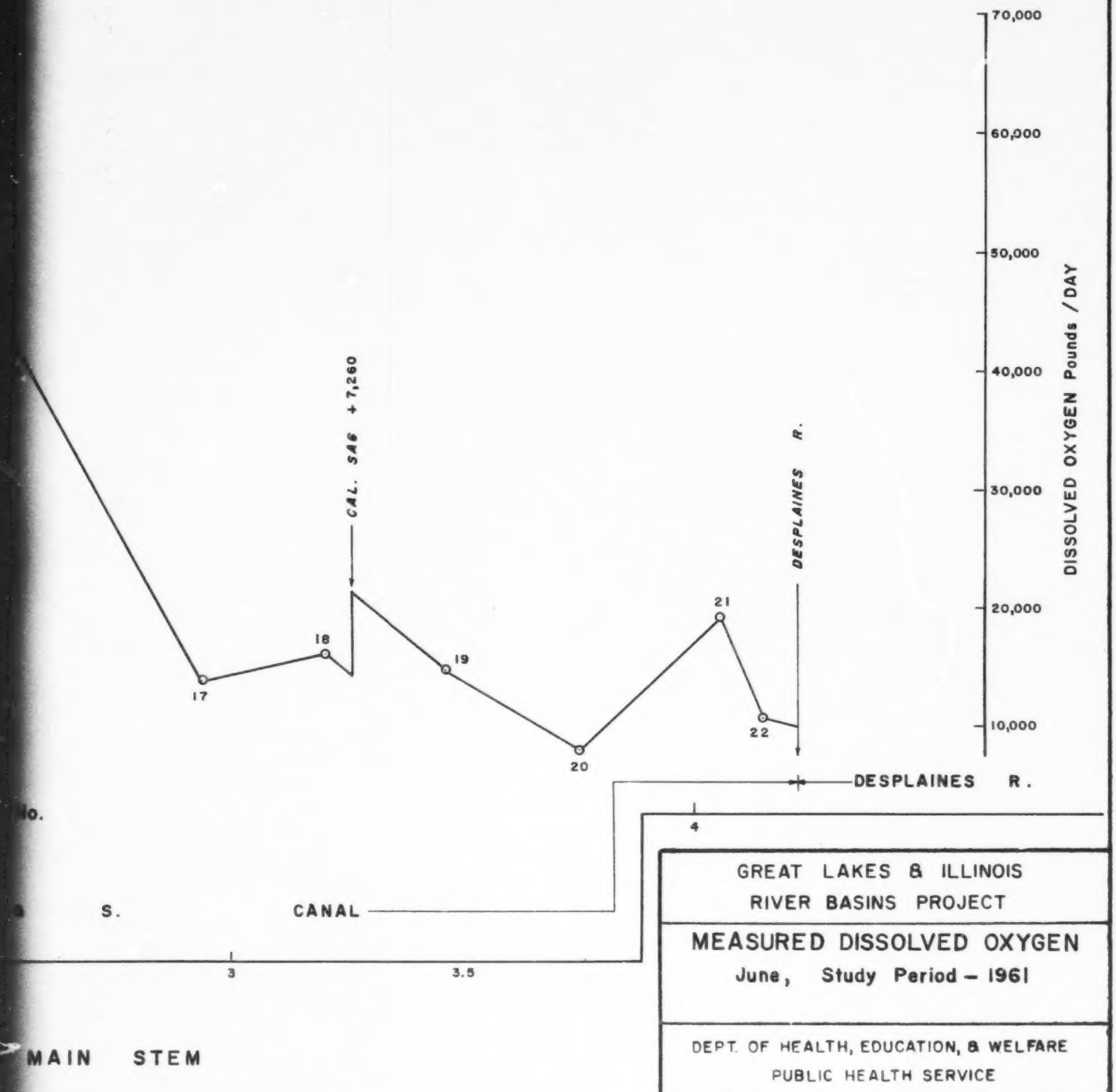

DISSOLVED OXYGEN Pounds / DAY
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
N.S.P. + 16,710
N. BRANCH + 1,720
CHICAGO R. + 21,000
1
2
3
4
5
6
7
8
9
12
13
14
15
N. S. CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS FROM NO

B


12
13
14
15
W.S.W.P. + 46,200
16
17
18
CAL. SAG + 7,260
19
20
LEGEND
○ 20 Sampling Sta. No.
S. BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
OF TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

C

64



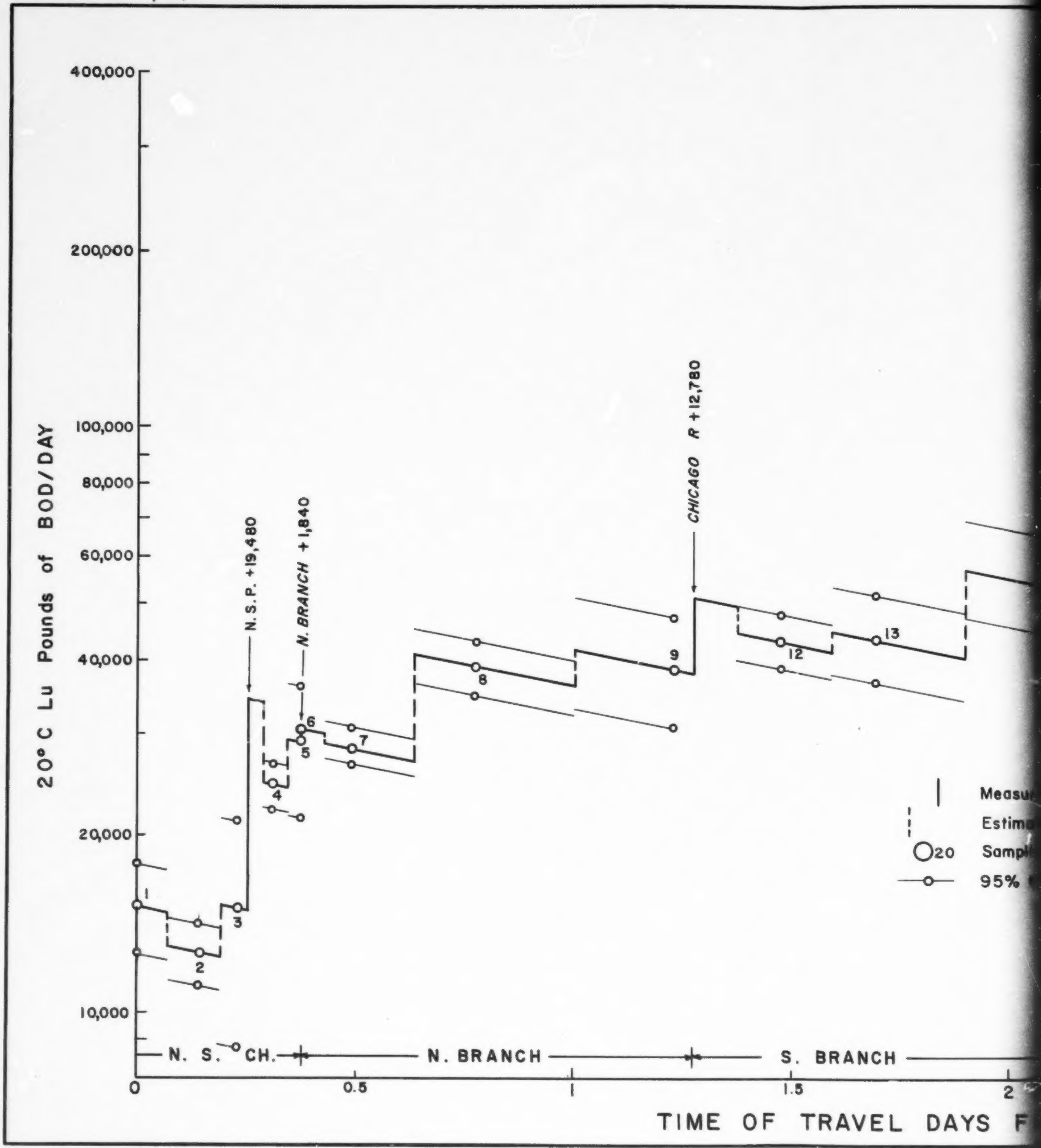
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

MEASURED DISSOLVED OXYGEN
June, Study Period – 1961

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

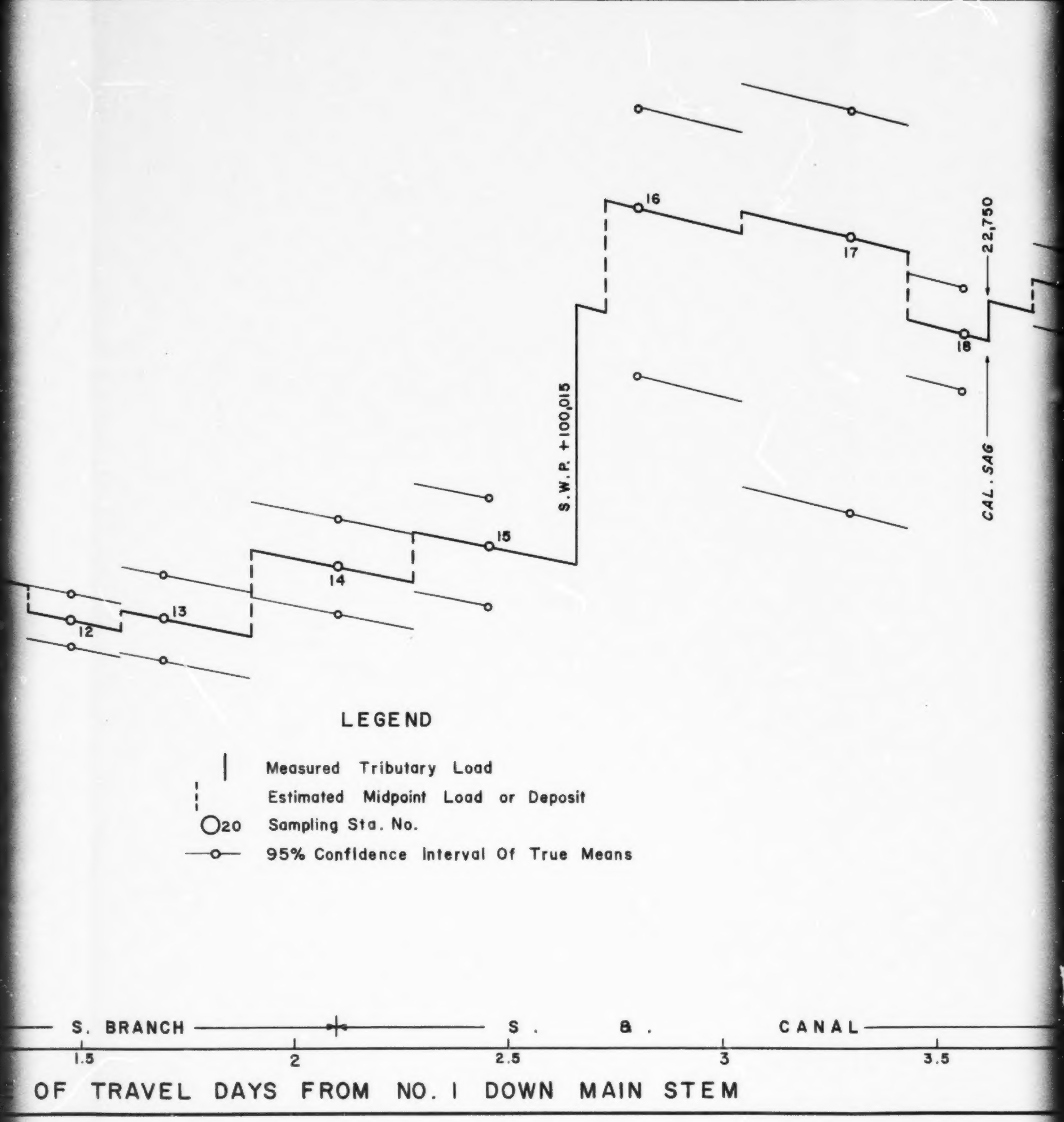
FIGURE 4

A



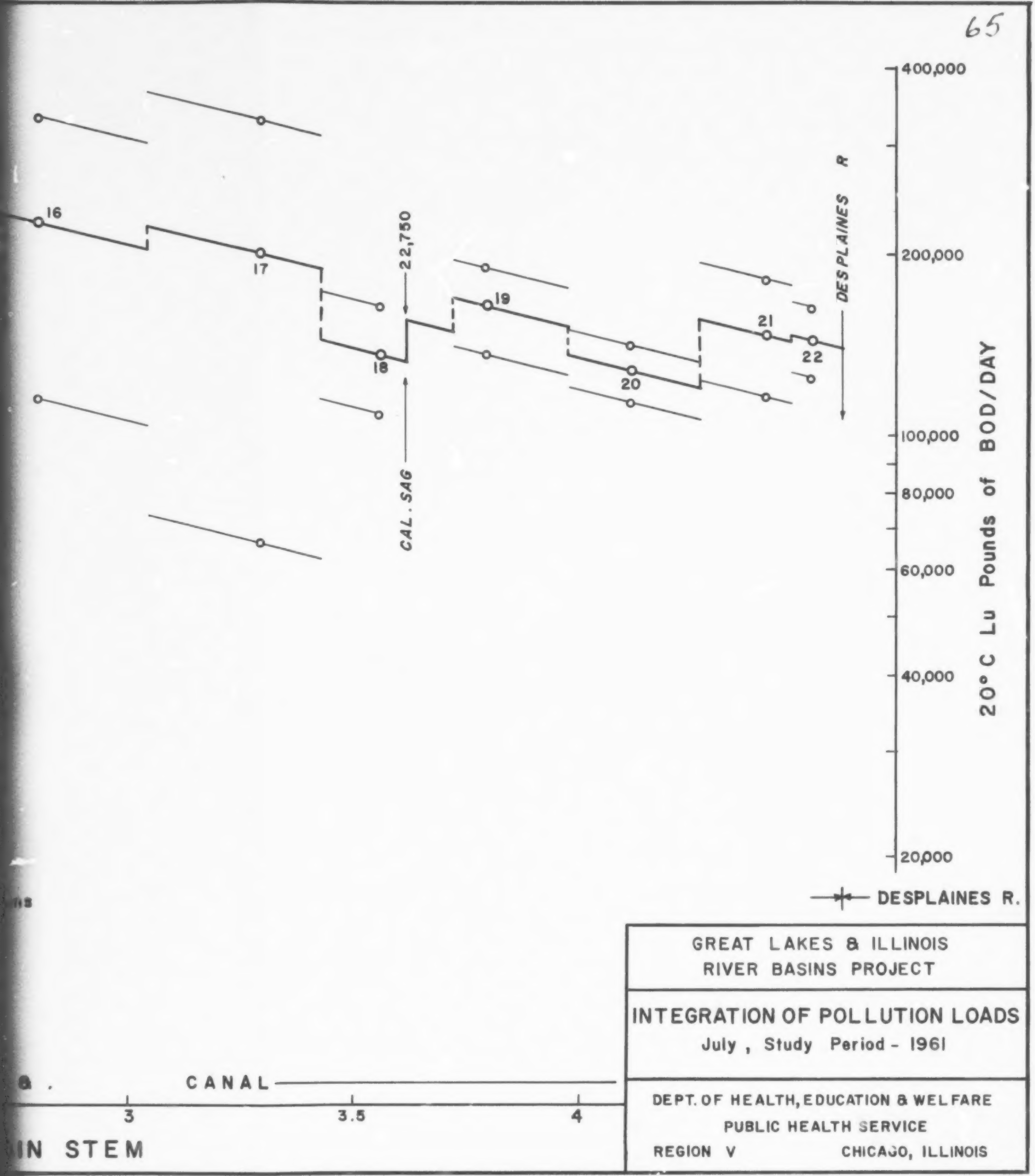
20° C Lu Pounds of BOD/DAY
400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
N.S.P. +19,480
N. BRANCH +1,840
CHICAGO R +12,780
1
2
3
4
5
6
7
8
9
12
13
N. S. CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS F
Measu
Estima
20 Sampl
95%

B


16
17
18
15
14
13
12
S.W.P. +100,015
22,750
CAL. SAG
LEGEND
Measured Tributary Load
Estimated Midpoint Load or Deposit
20 Sampling Sta. No.
95% Confidence Interval Of True Means
S. BRANCH
S. & CANAL
1.5
2
2.5
3
3.5
OF TRAVEL DAYS FROM NO. I DOWN MAIN STEM

C

65



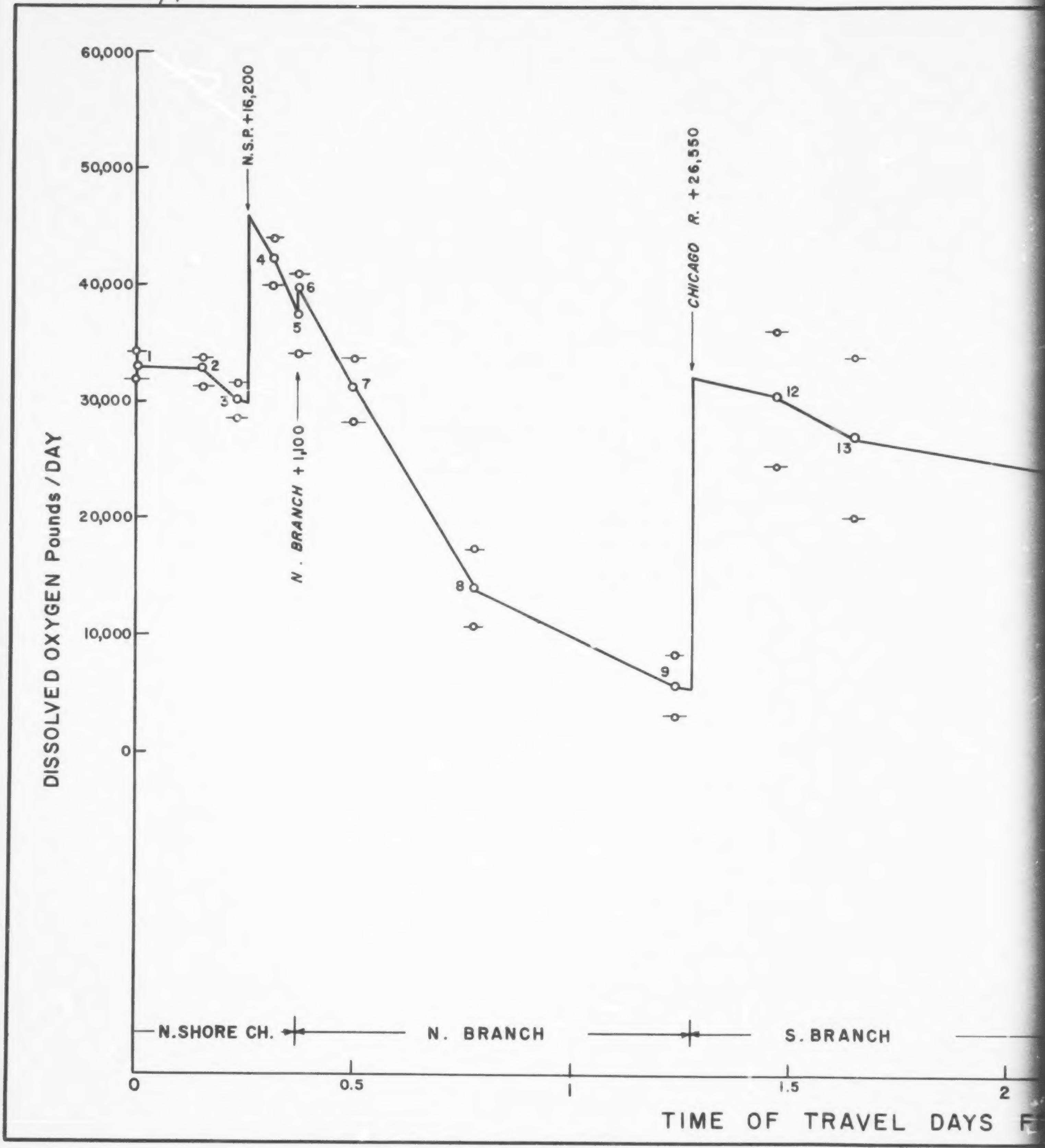
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
July, Study Period - 1961

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

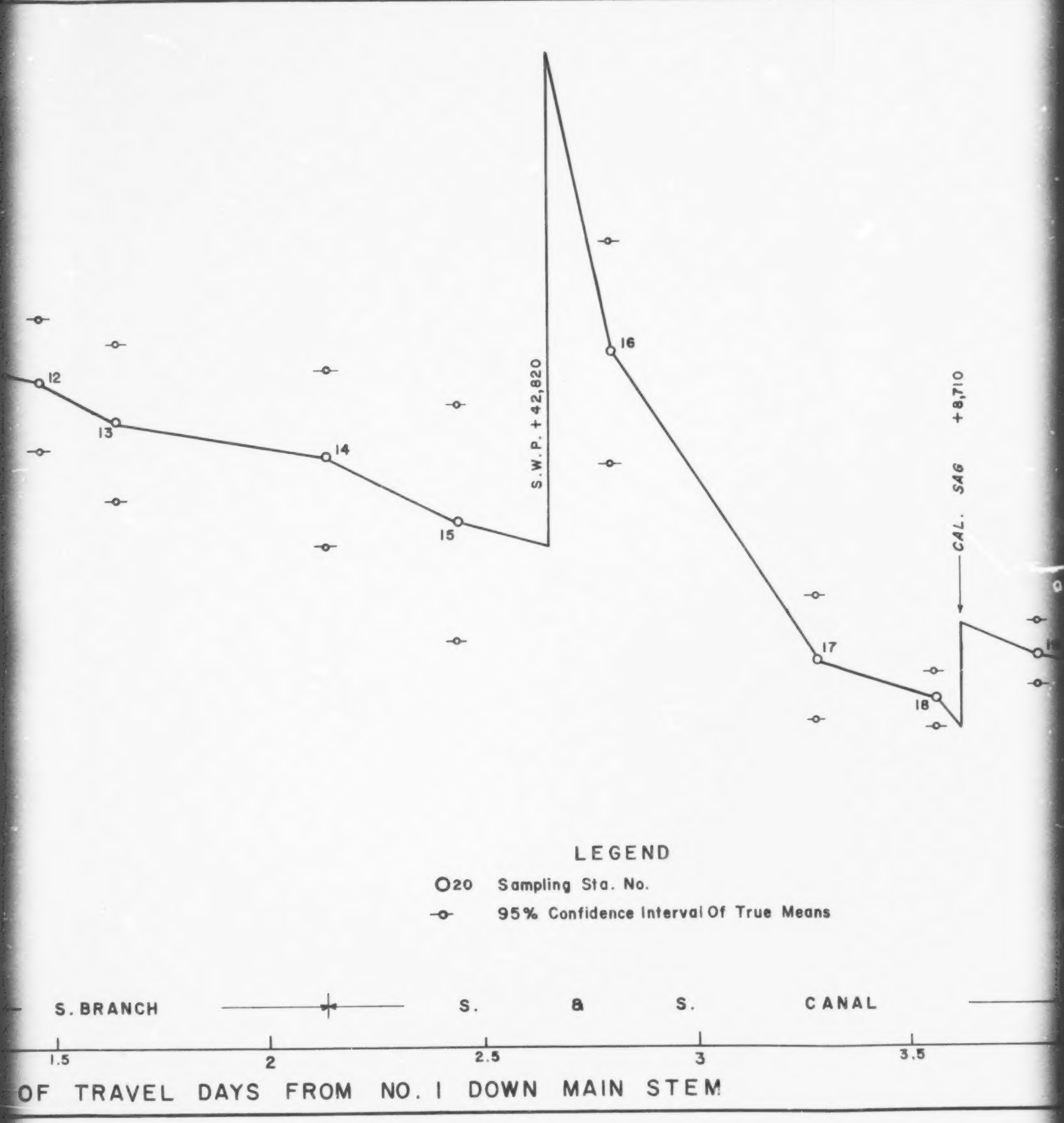
FIGURE 5

A

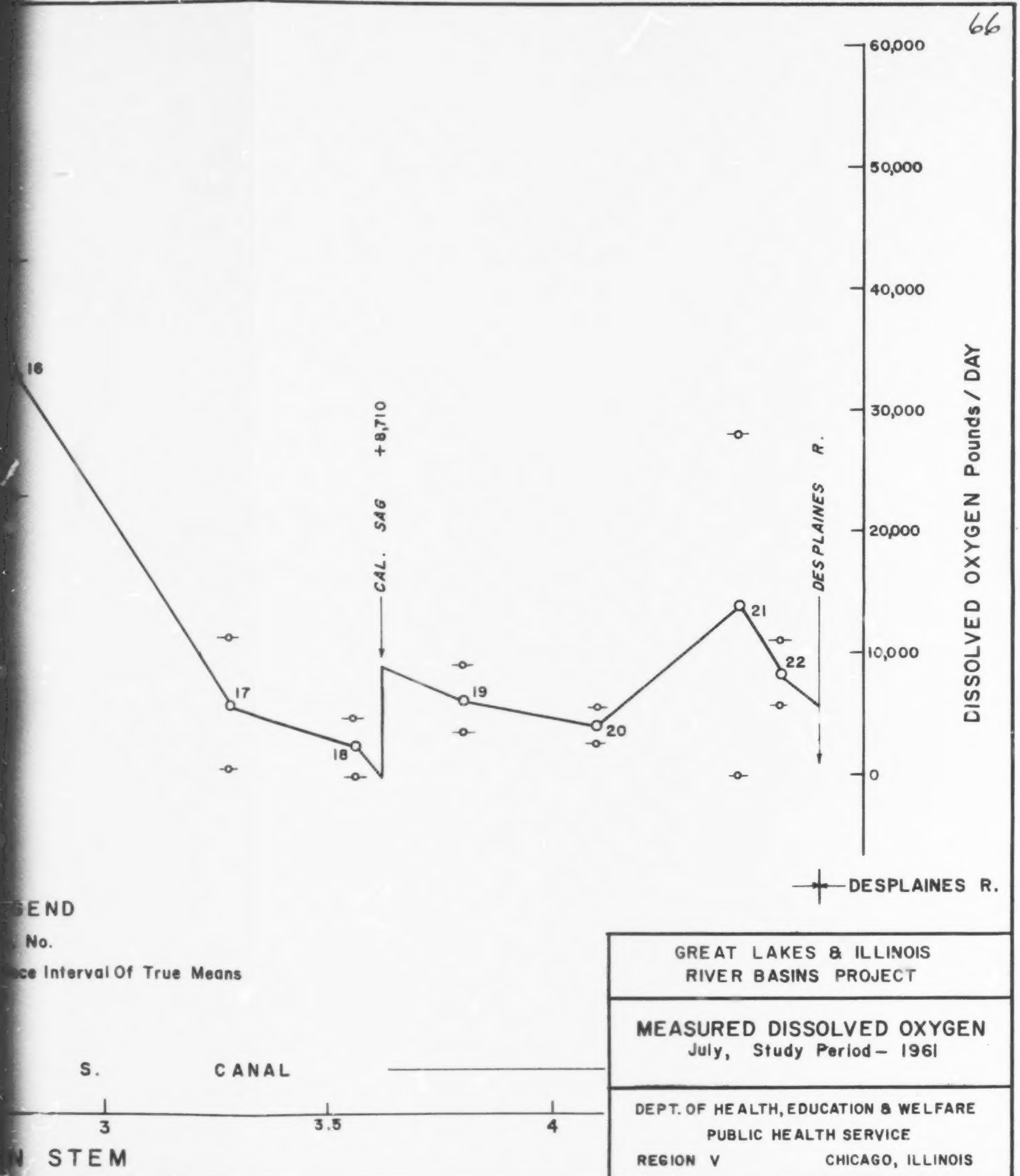


60,000
50,000
40,000
30,000
20,000
10,000
0
DISSOLVED OXYGEN Pounds / DAY
N.S.P. +16,200
N. BRANCH + 1,100
CHICAGO R. +26,550
1
2
3
4
5
6
7
8
9
12
13
N.SHORE CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS F

B


12
13
14
15
16
17
18
S.W.P. + 42,820
CAL. SAG +8,710
LEGEND
O20 Sampling Sta. No.
95% Confidence Interval Of True Means
S. BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
OF TRAVEL DAYS FROM NO. I DOWN MAIN STEM

C



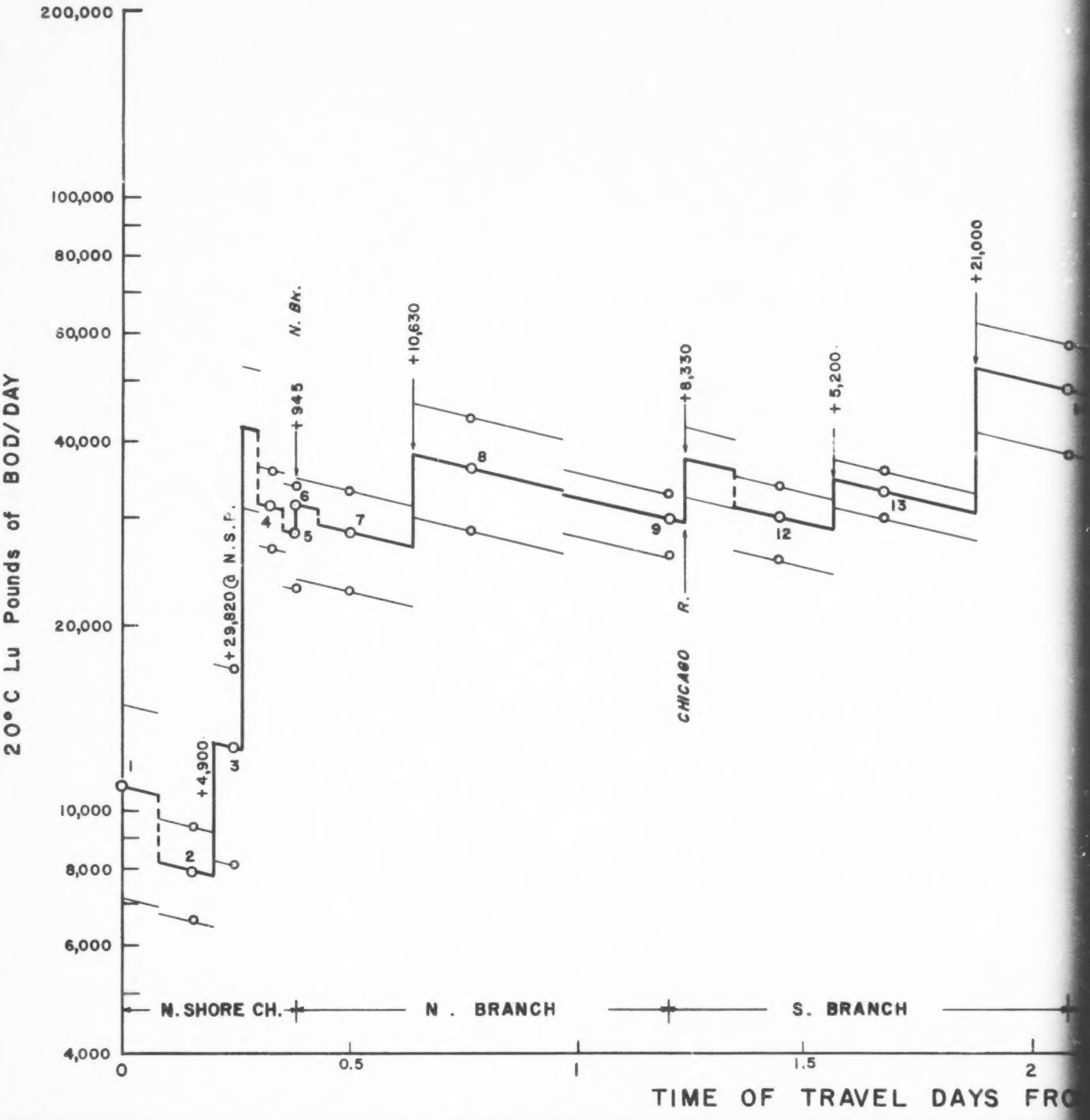
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

MEASURED DISSOLVED OXYGEN
July, Study Period – 1961

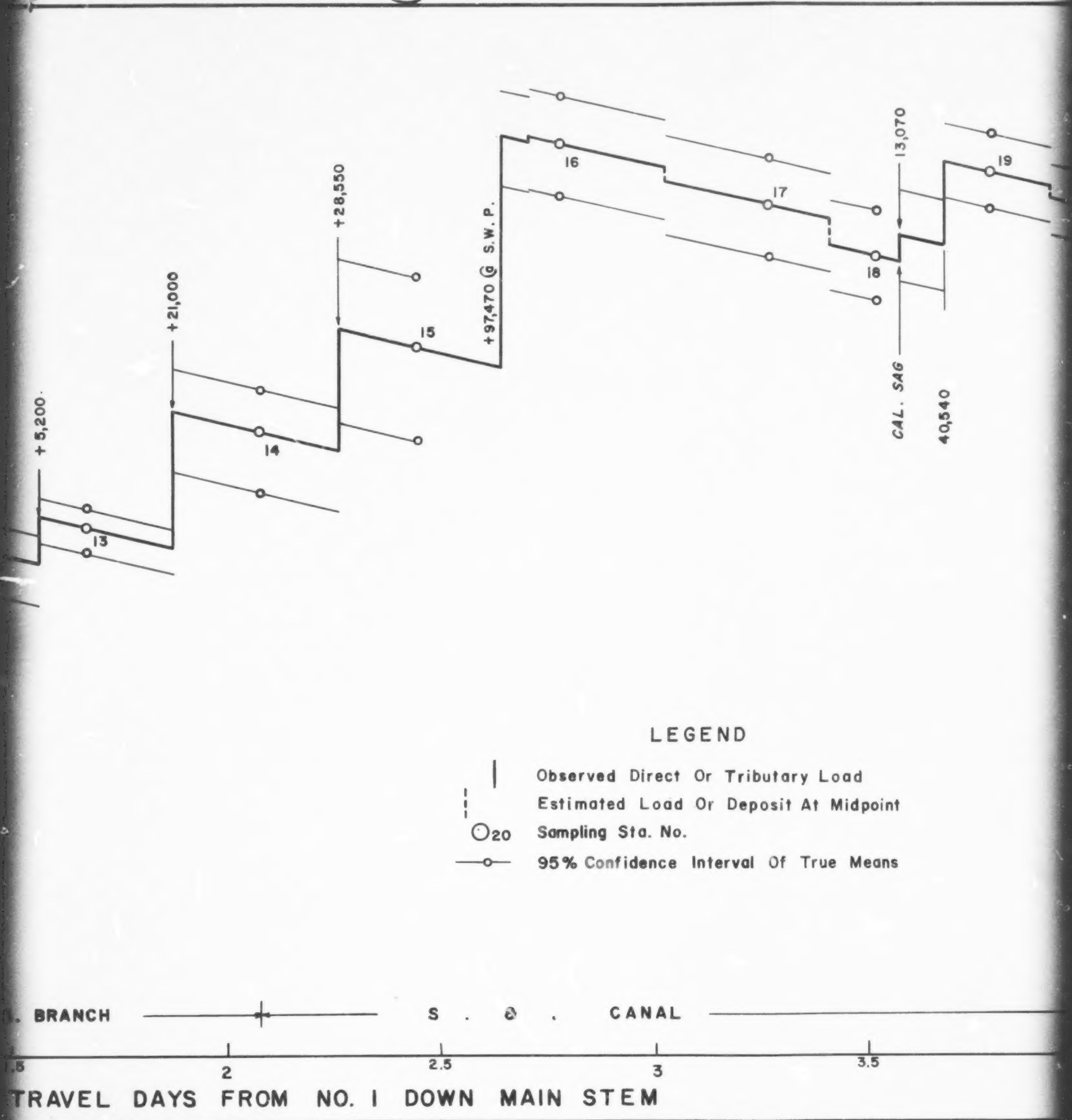
DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 6

A

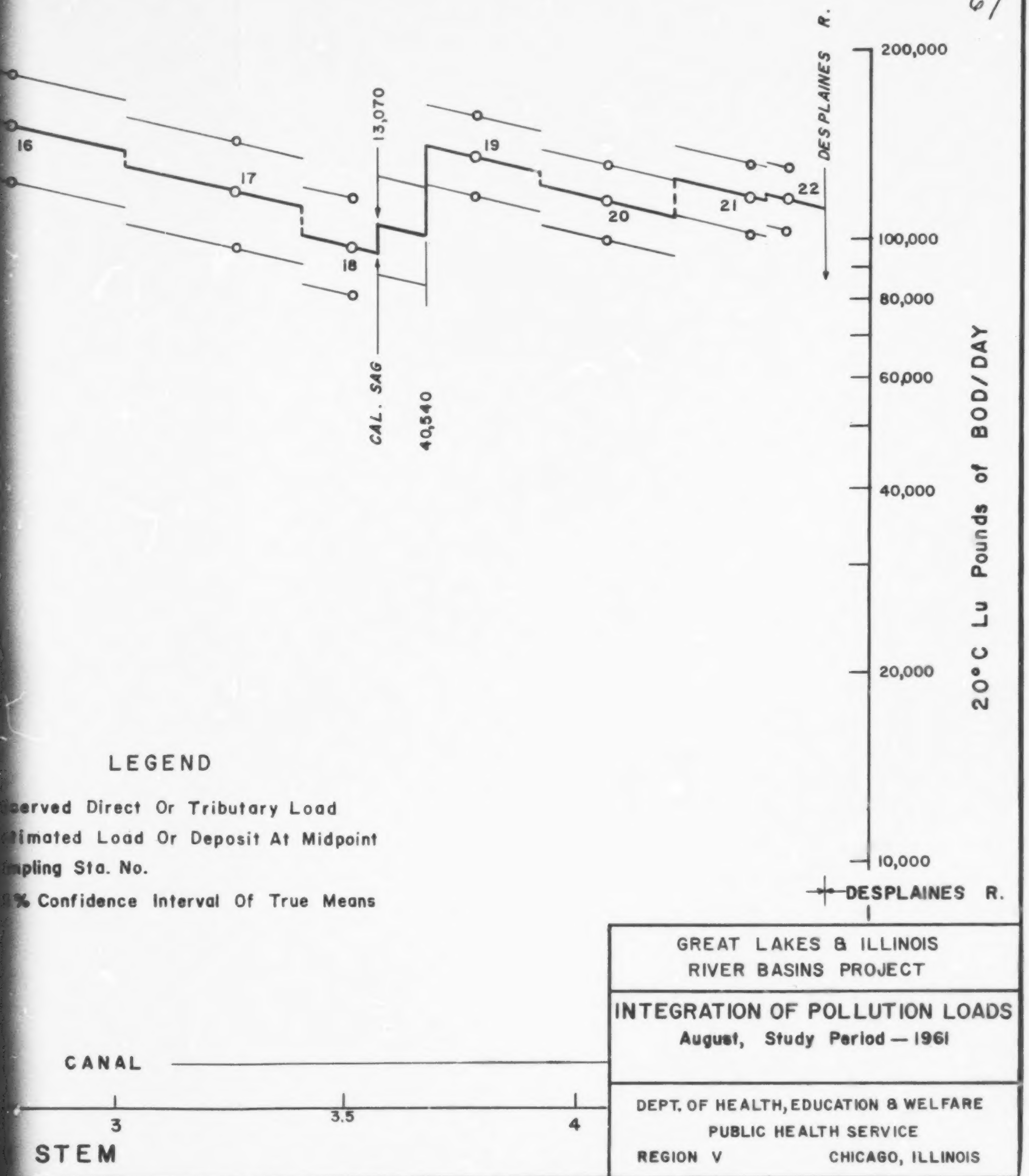

20°C Lu Pounds of BOD/DAY
200,000
100,000
80,000
60,000
40,000
20,000
10,000
8,000
6,000
4,000
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS FRO
1
2
3
4
5
6
7
8
9
12
13
+4,900
+29,820 @ N.S.P.
+945
N. Br.
+10,630
+8,330
CHICAGO R.
+5,200
+21,000
N. SHORE CH.
N. BRANCH
S. BRANCH

B



+ 5,200
+ 21,000
+ 28,550
+ 97,470 @ S.W.P.
13,070
CAL. SAG
40,540
13
14
15
16
17
18
19
LEGEND
Observed Direct Or Tributary Load
Estimated Load Or Deposit At Midpoint
20 Sampling Sta. No.
95% Confidence Interval Of True Means
. BRANCH
S . & . CANAL
.5
2
2.5
3
3.5
TRAVEL DAYS FROM NO. I DOWN MAIN STEM

C



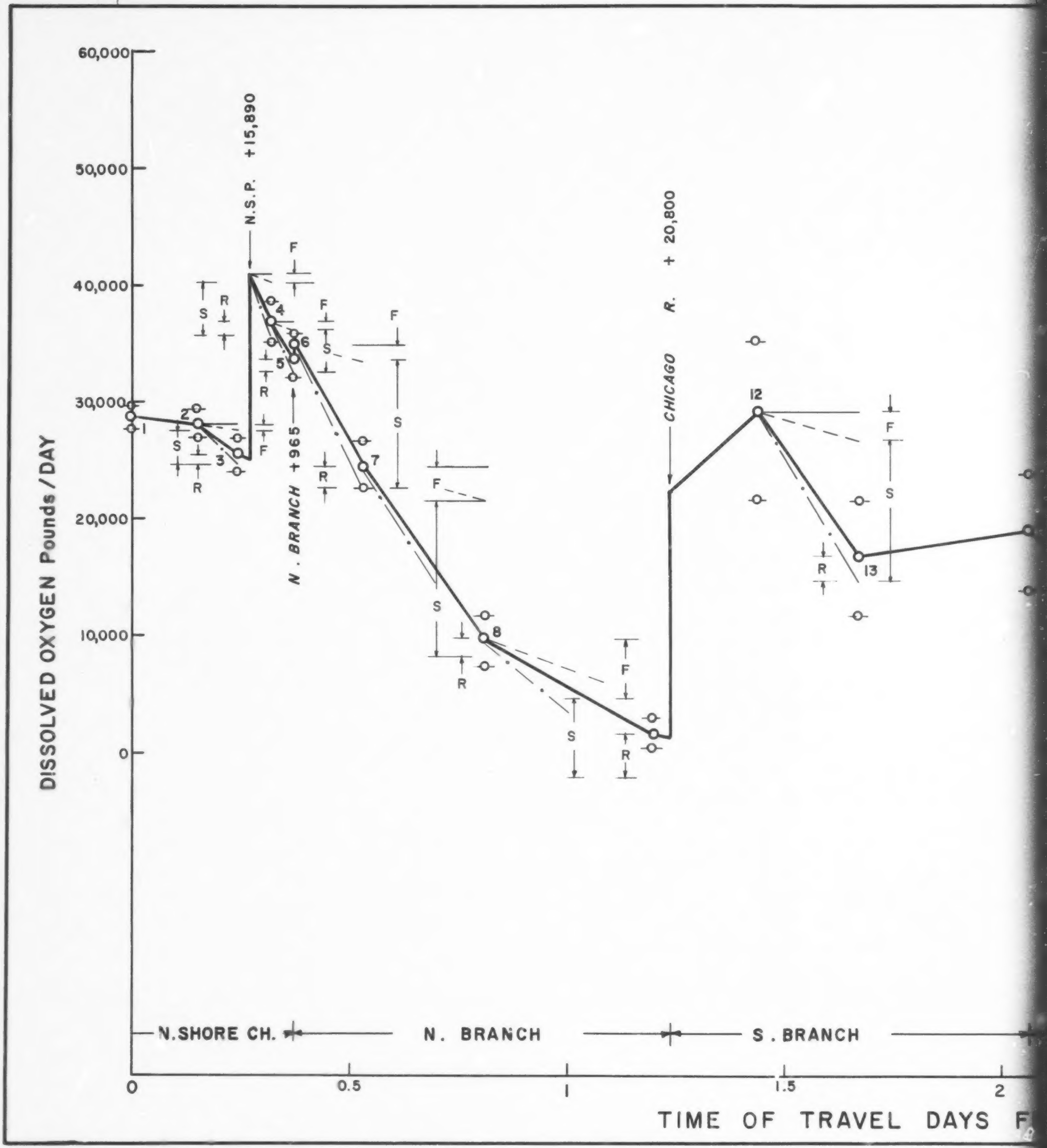
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
August, Study Period — 1961

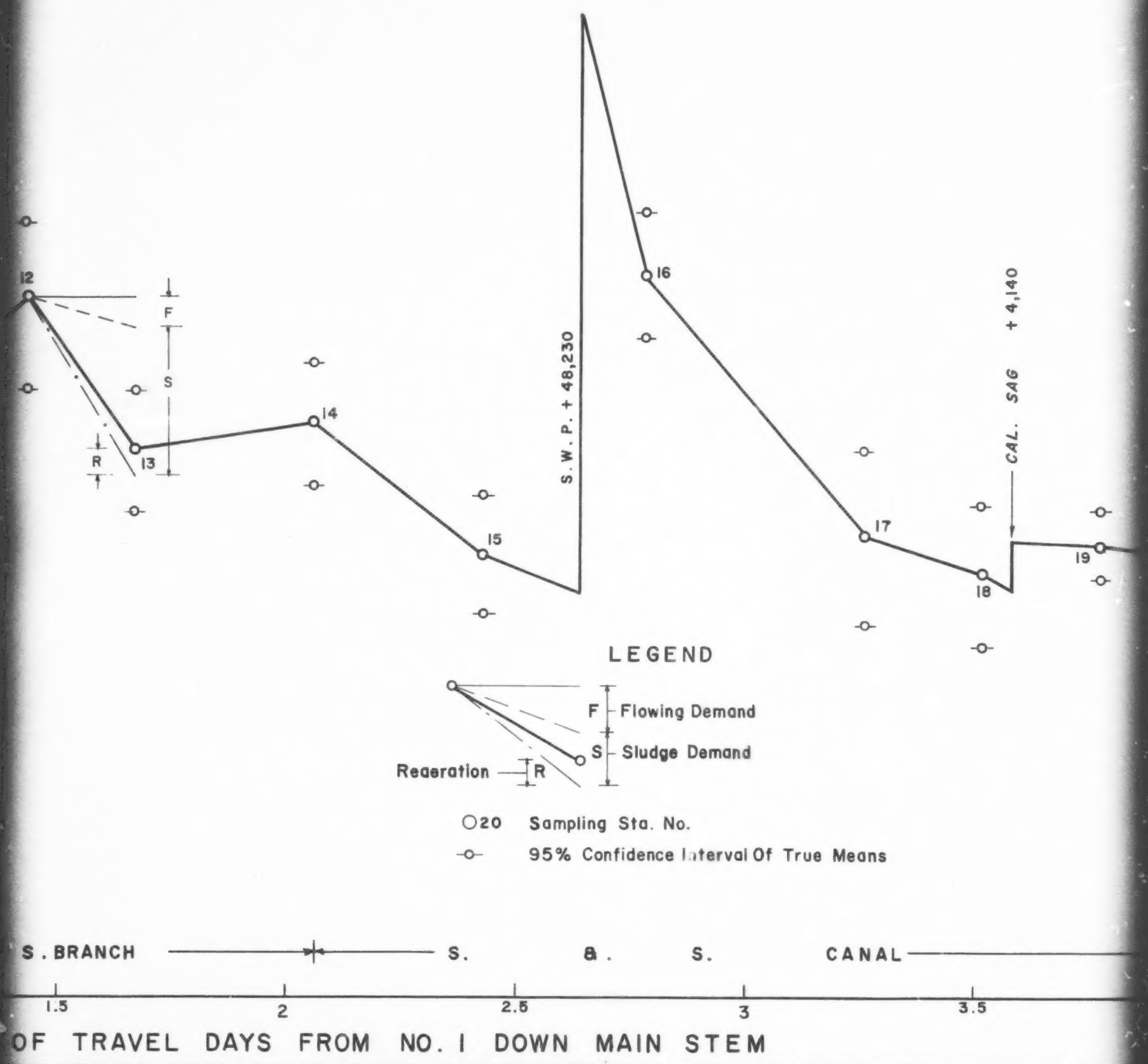
DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 7

A

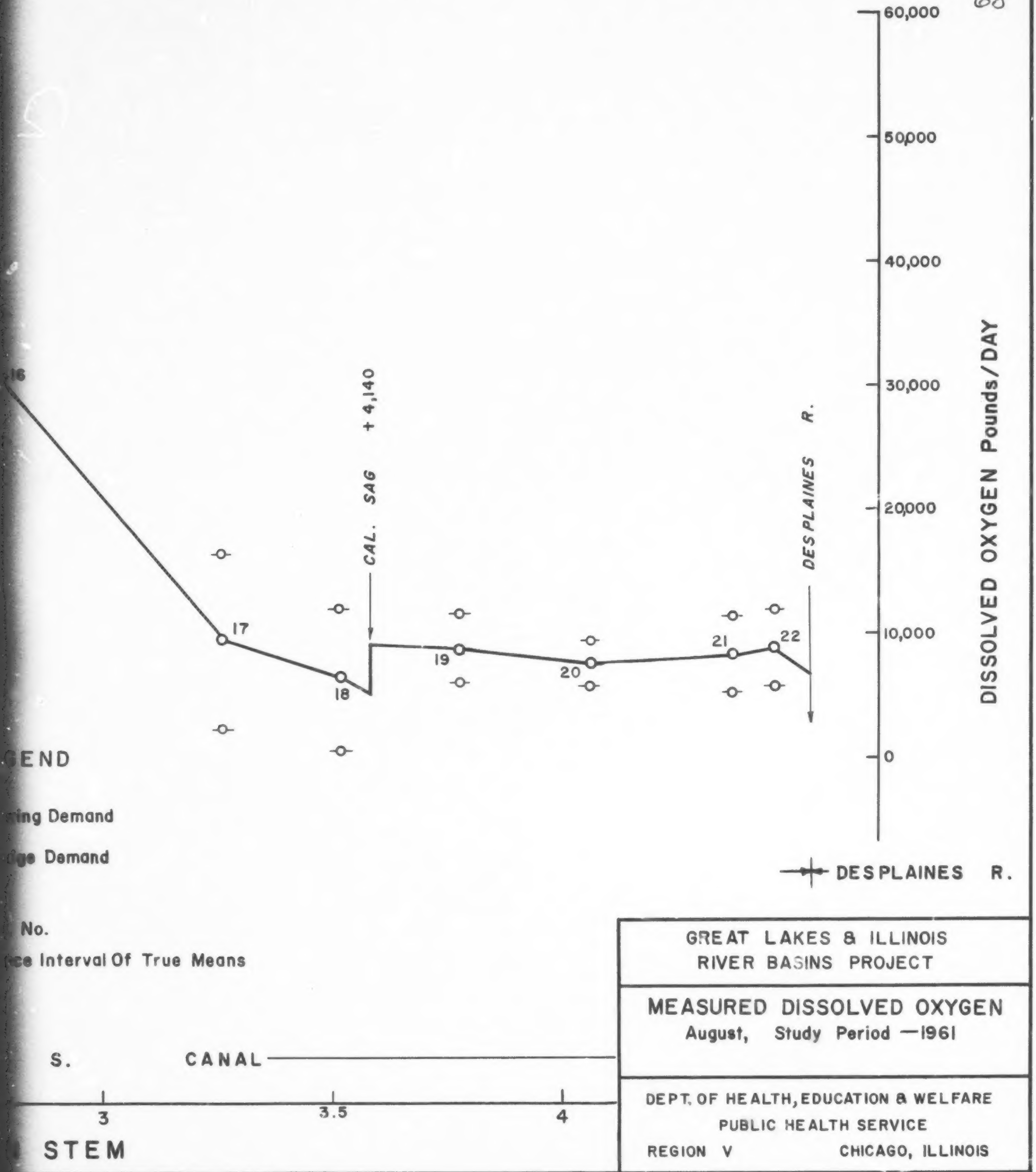

DISSOLVED OXYGEN Pounds/DAY
60,000
50,000
40,000
30,000
20,000
10,000
0
N.S.P. +15,890
N. BRANCH +965
CHICAGO R. + 20,800
1
2
3
4
5
6
7
8
12
13
S
R
F
N.SHORE CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS F

B


12
F
S
R
13
14
15
S. W. P. + 48,230
16
17
18
CAL. SAG + 4,140
19
LEGEND
F - Flowing Demand
S - Sludge Demand
Reaeration R
○20 Sampling Sta. No.
-o- 95% Confidence Interval Of True Means
S. BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
OF TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

c

68



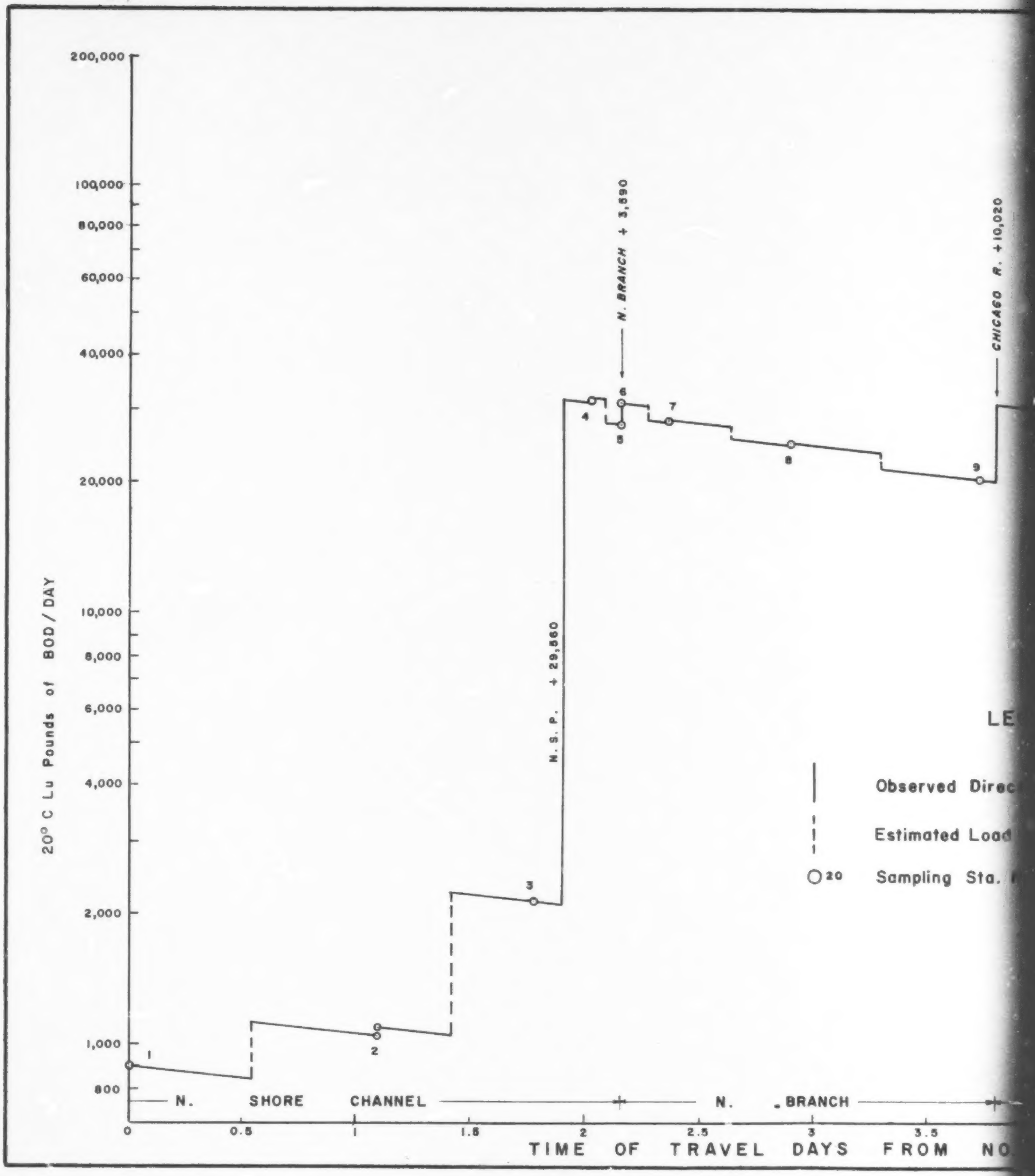
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

MEASURED DISSOLVED OXYGEN
August, Study Period —1961

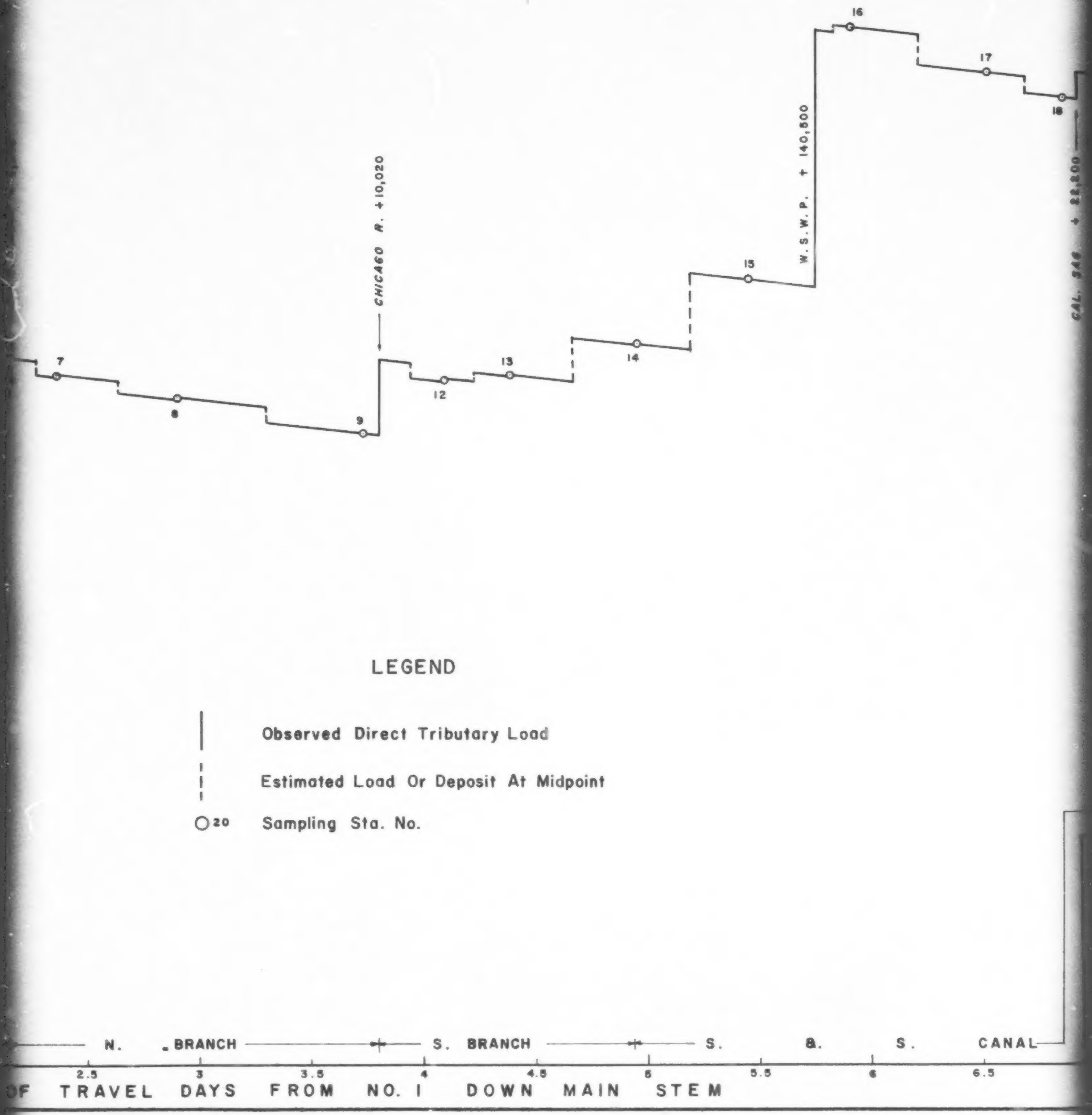
DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 8

A

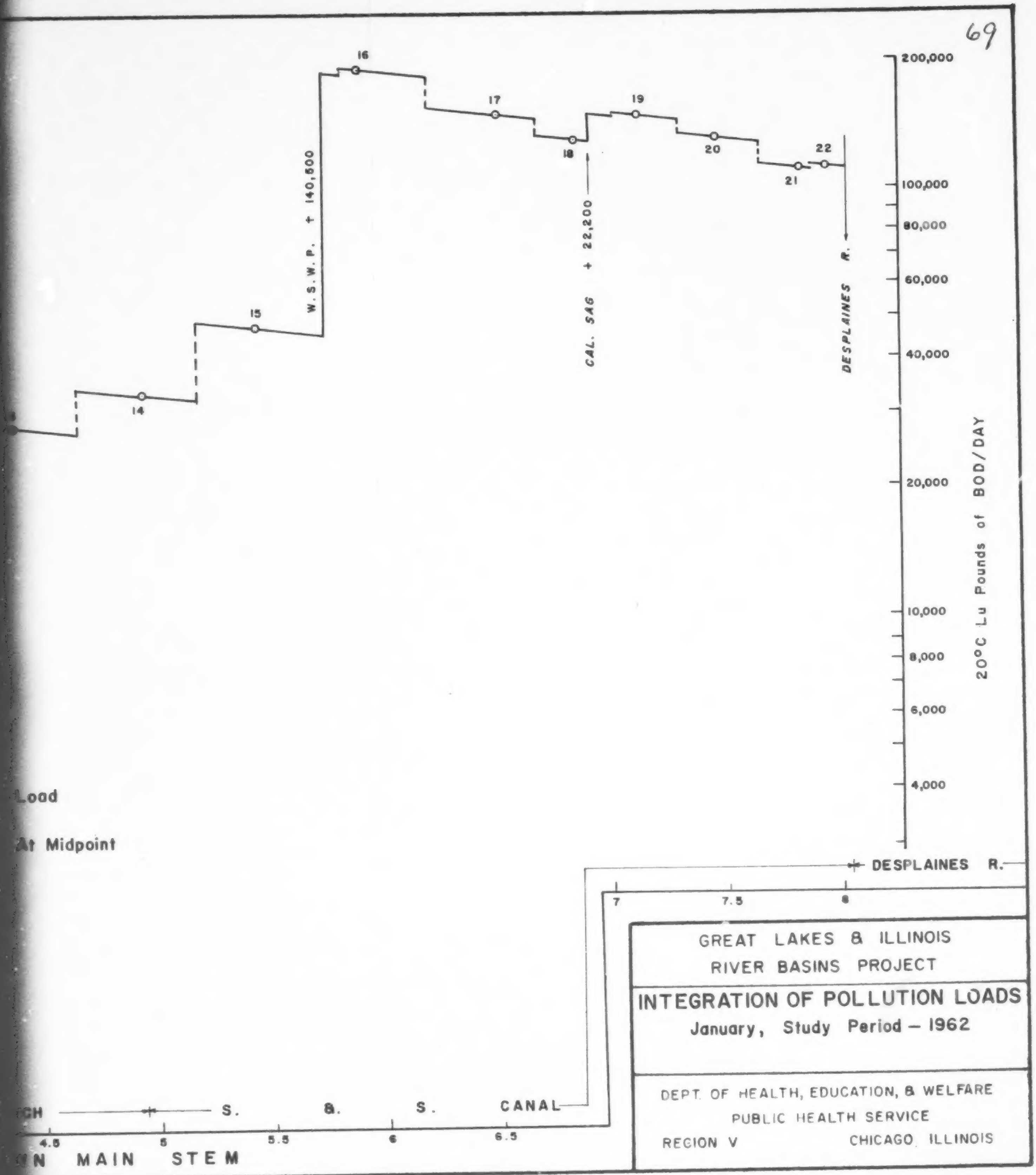

200,000
100,000
80,000
60,000
40,000
20,000
10,000
8,000
6,000
4,000
2,000
1,000
800
20° C Lu Pounds of BOD / DAY
N. BRANCH + 3,590
CHICAGO R. +10,020
N. S. P. + 29,560
1
2
3
4
5
6
7
8
9
LE
Observed Direc
Estimated Load
20
Sampling Sta.
N. SHORE CHANNEL
N. BRANCH
0
0.5
1
1.5
2
2.5
3
3.5
TIME OF TRAVEL DAYS FROM NO

B



7
8
9
CHICAGO R. +10,020
12
13
14
15
W. S. W. P. + 140,500
16
17
18
CAL. SAG + 22,800
LEGEND
Observed Direct Tributary Load
Estimated Load Or Deposit At Midpoint
○20 Sampling Sta. No.
N. BRANCH
S. BRANCH
S. & S. CANAL
2.5
3
3.5
4
4.5
5
5.5
6
6.5
OF TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

C



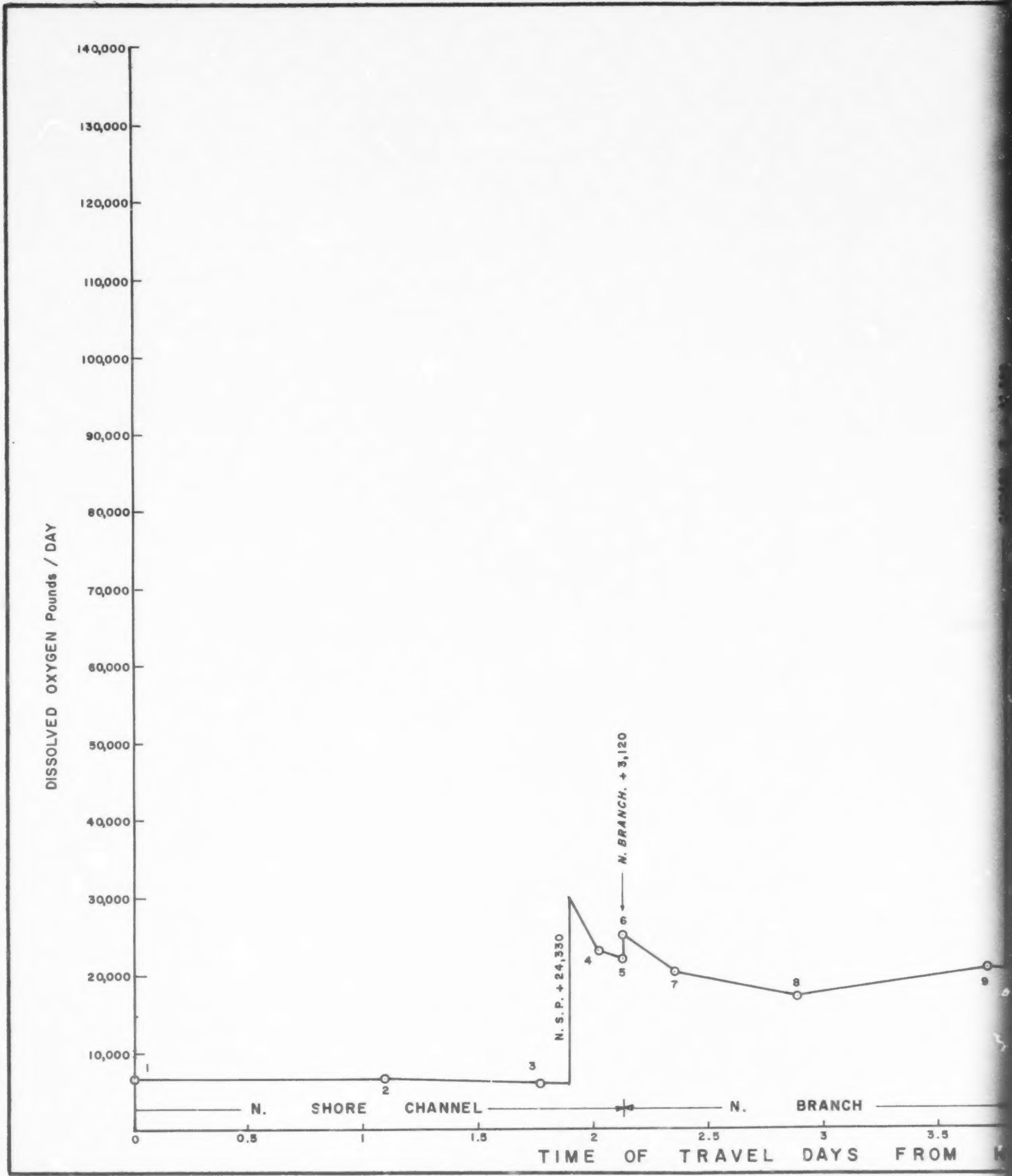
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
January, Study Period – 1962

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

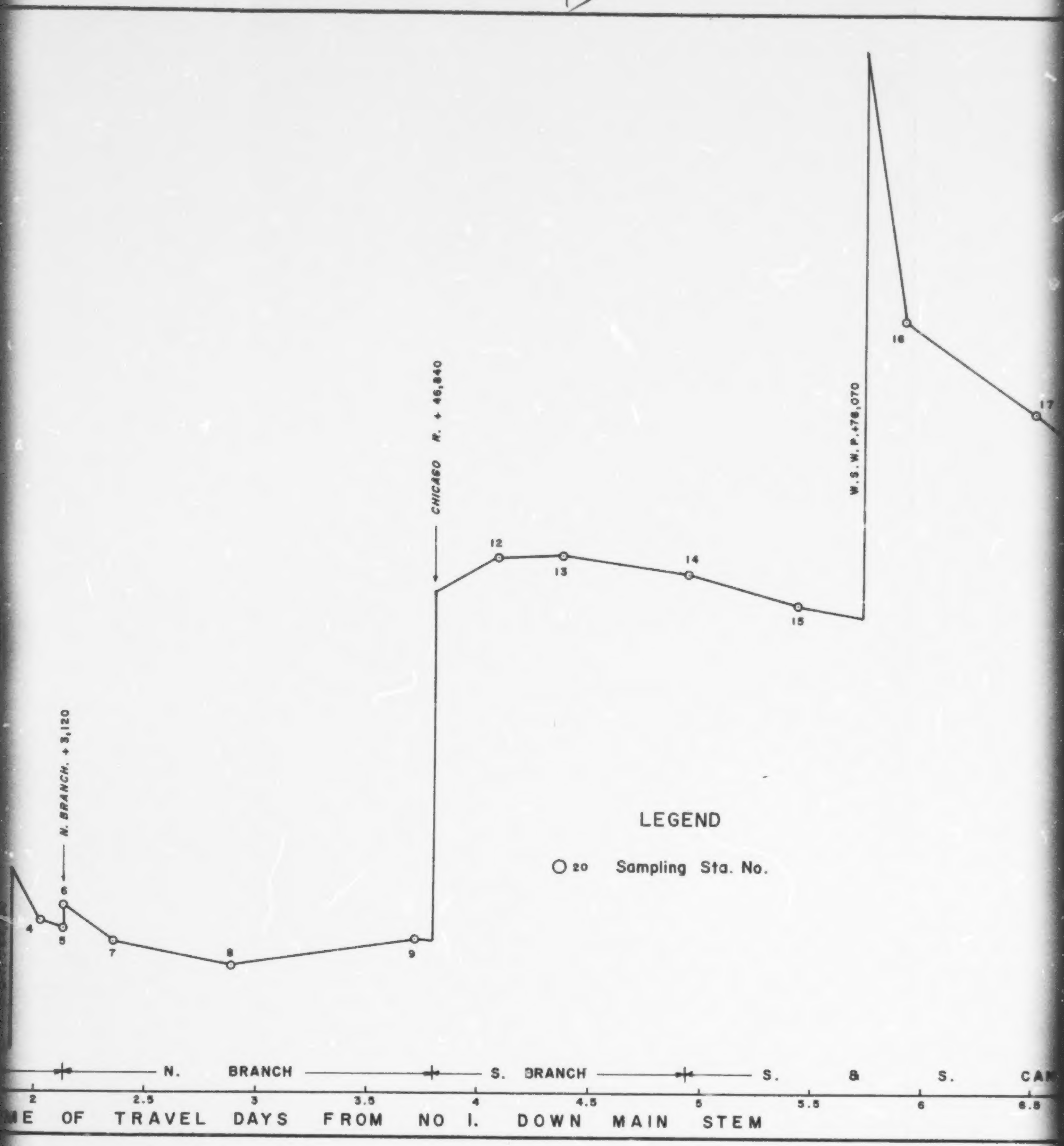
FIGURE 9

A

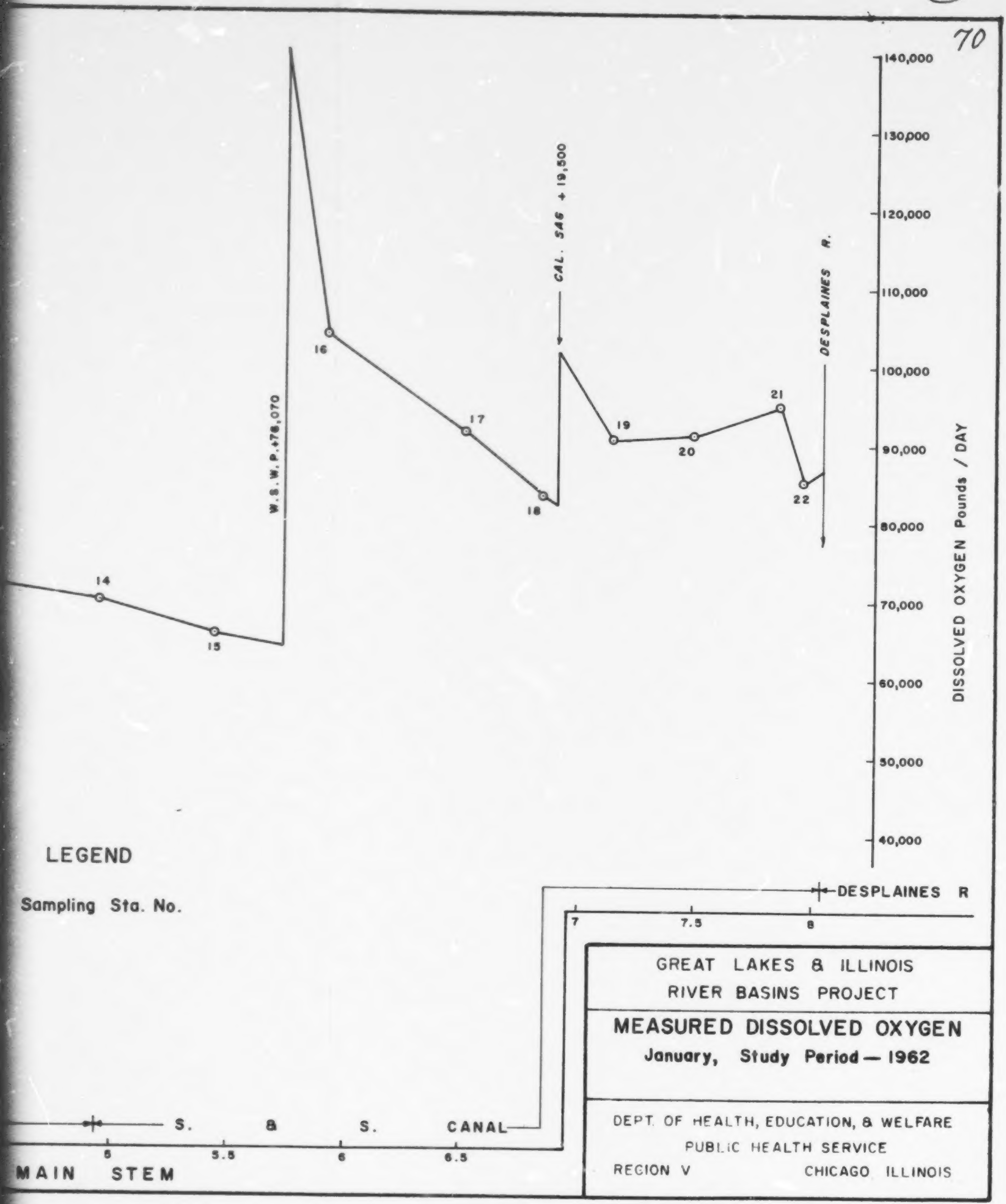


140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
DISSOLVED OXYGEN Pounds / DAY
1
2
3
4
5
6
7
8
9
N. S. P. + 24,330
N. BRANCH. + 3,120
N. SHORE CHANNEL
N. BRANCH
0
0.5
1
1.5
2
2.5
3
3.5
TIME OF TRAVEL DAYS FROM

B



N. BRANCH. + 3,120
CHICAGO R. + 46,840
W.S.W.P.+78,070
4
5
6
7
8
9
12
13
14
15
16
17
LEGEND
○ 20 Sampling Sta. No.
N. BRANCH
S. BRANCH
S. & S. CA
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
ME OF TRAVEL DAYS FROM NO 1. DOWN MAIN STEM



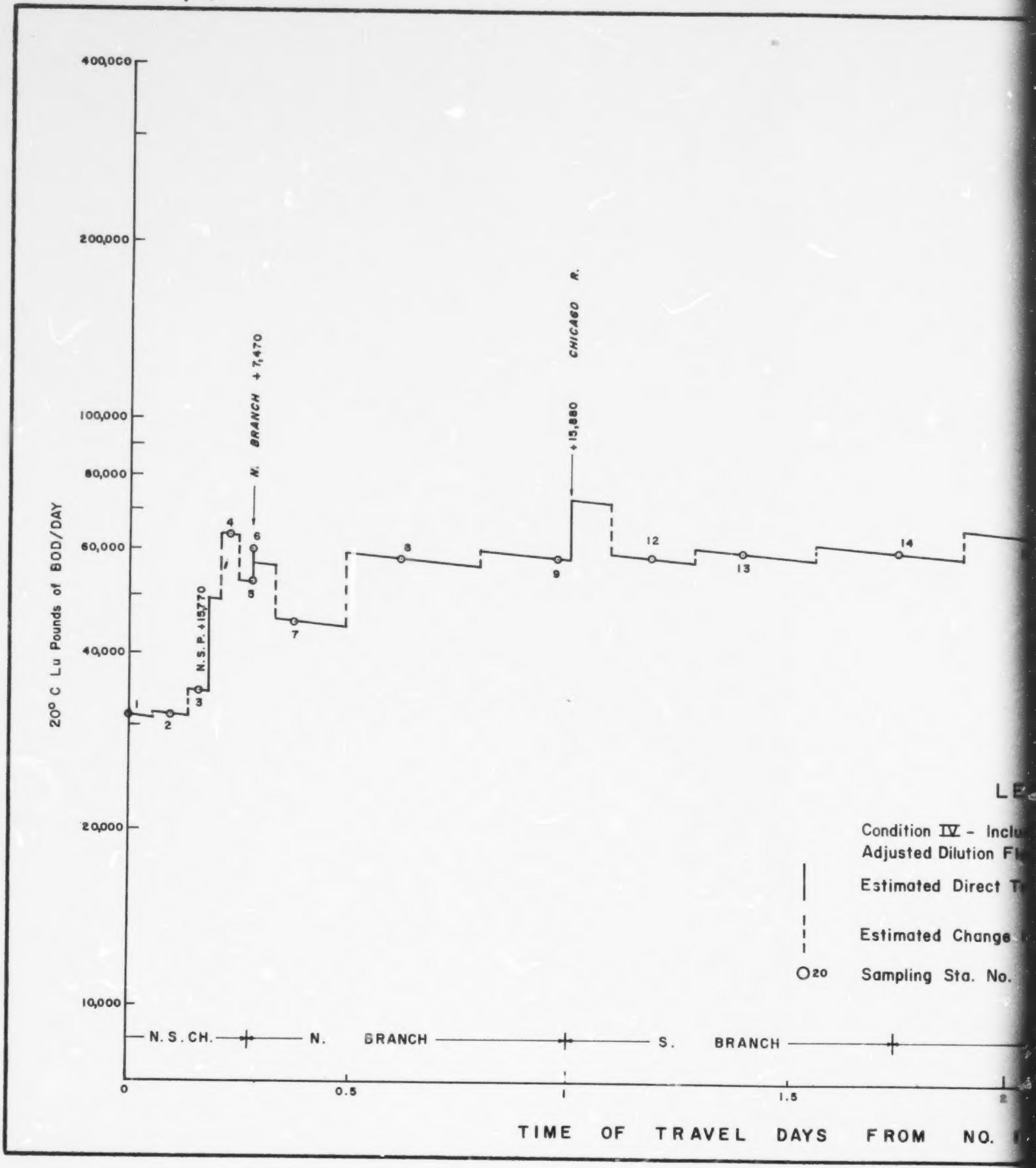
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

MEASURED DISSOLVED OXYGEN
January, Study Period — 1962

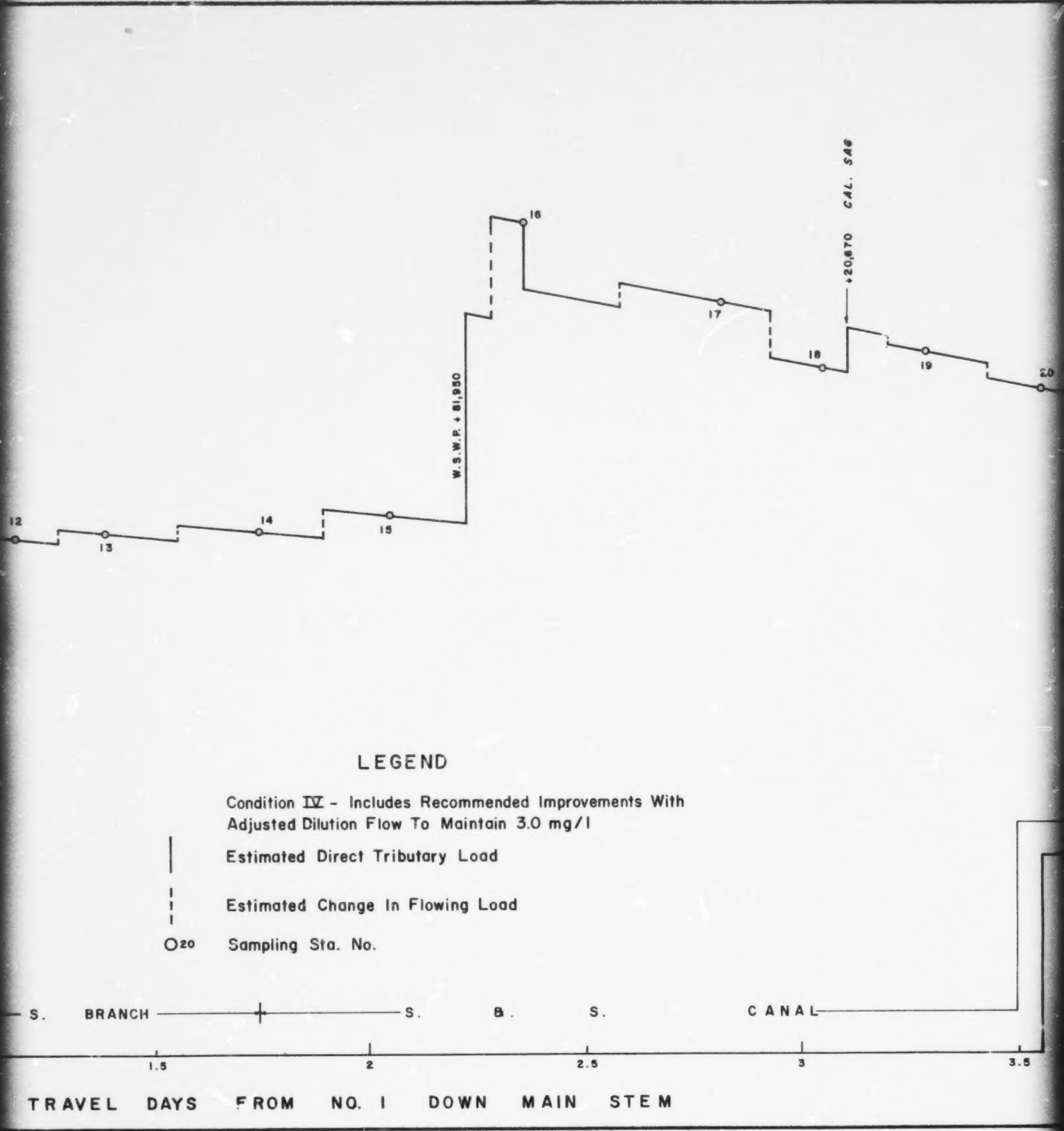
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO ILLINOIS

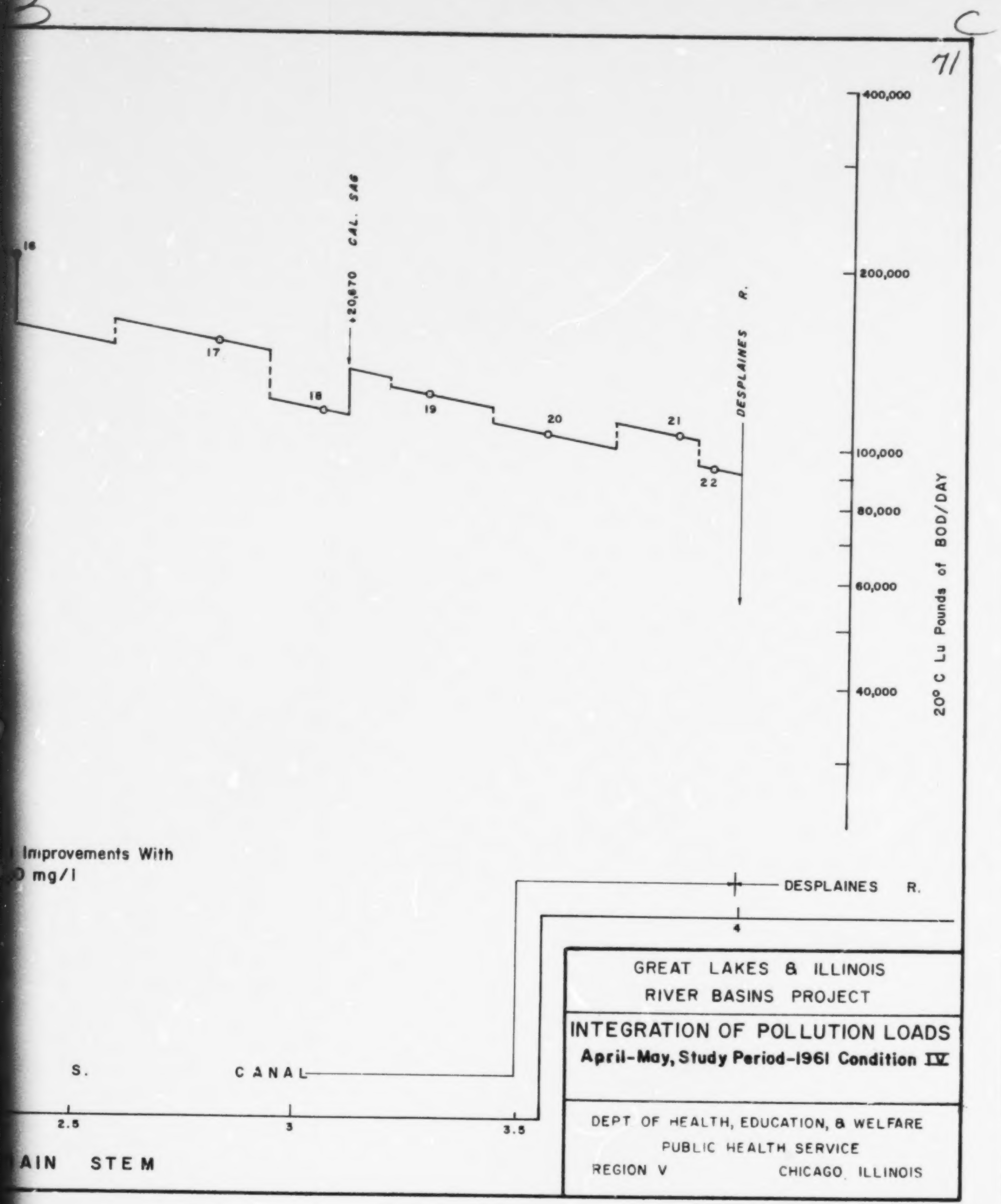
FIGURE 10

A


20° C Lu Pounds of BOD/DAY
400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
N.S.P. +15,770
N. BRANCH + 7,470
CHICAGO R. +15,880
1
2
3
4
5
6
7
8
9
12
13
14
N.S.CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS FROM NO.
LE
Condition IV - Inclu
Adjusted Dilution Fl
Estimated Direct T
Estimated Change
O20 Sampling Sta. No.

B


12
13
14
15
W.S.W.P. + 81,950
16
17
18
+20,870 CAL. SAG
19
20
LEGEND
Condition IV - Includes Recommended Improvements With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
Estimated Change In Flowing Load
O20 Sampling Sta. No.
S. BRANCH
S. B. S. CANAL
1.5
2
2.5
3
3.5
TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM



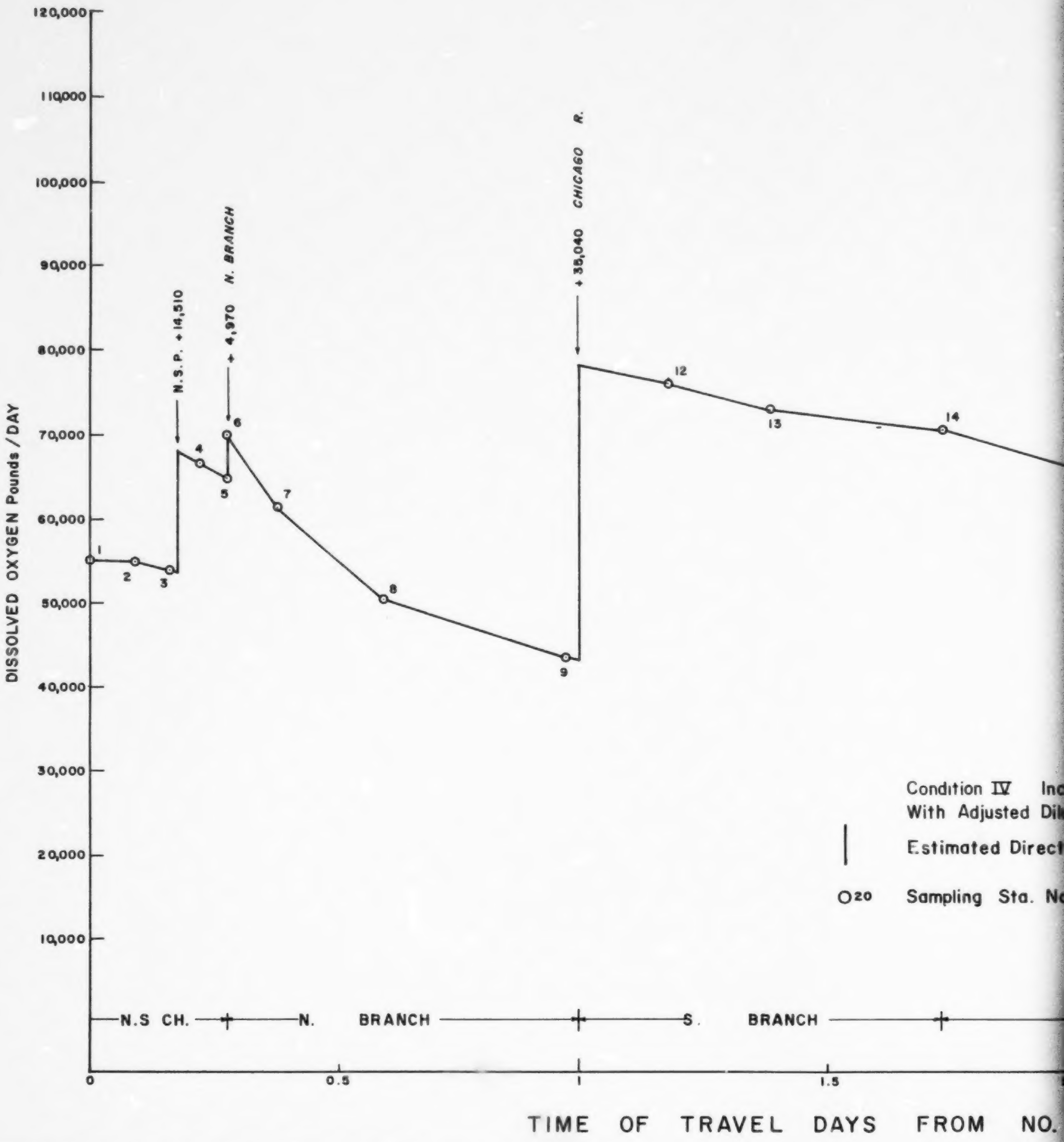
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
April-May, Study Period-1961 Condition IV

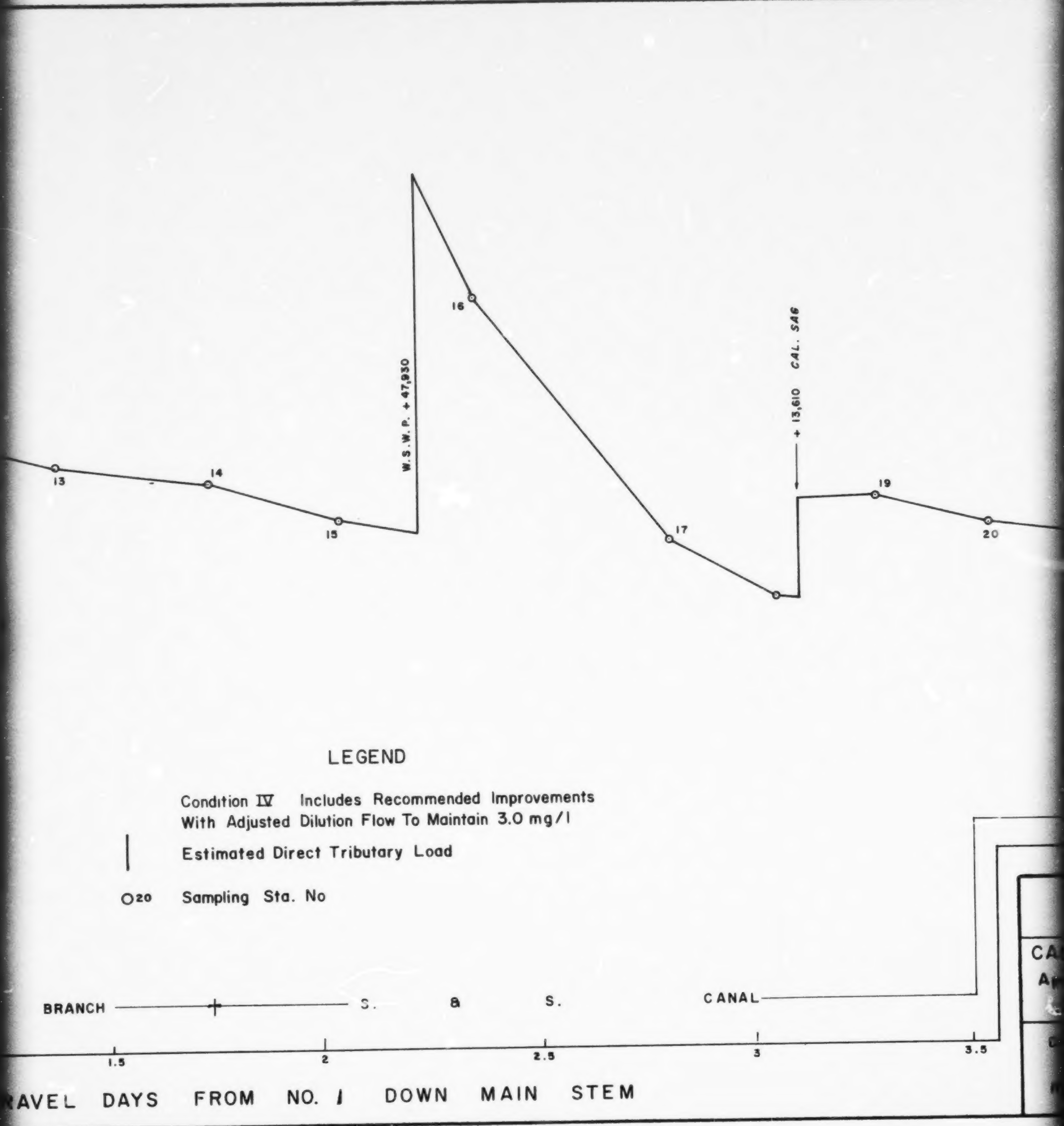
DEPT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 11

A

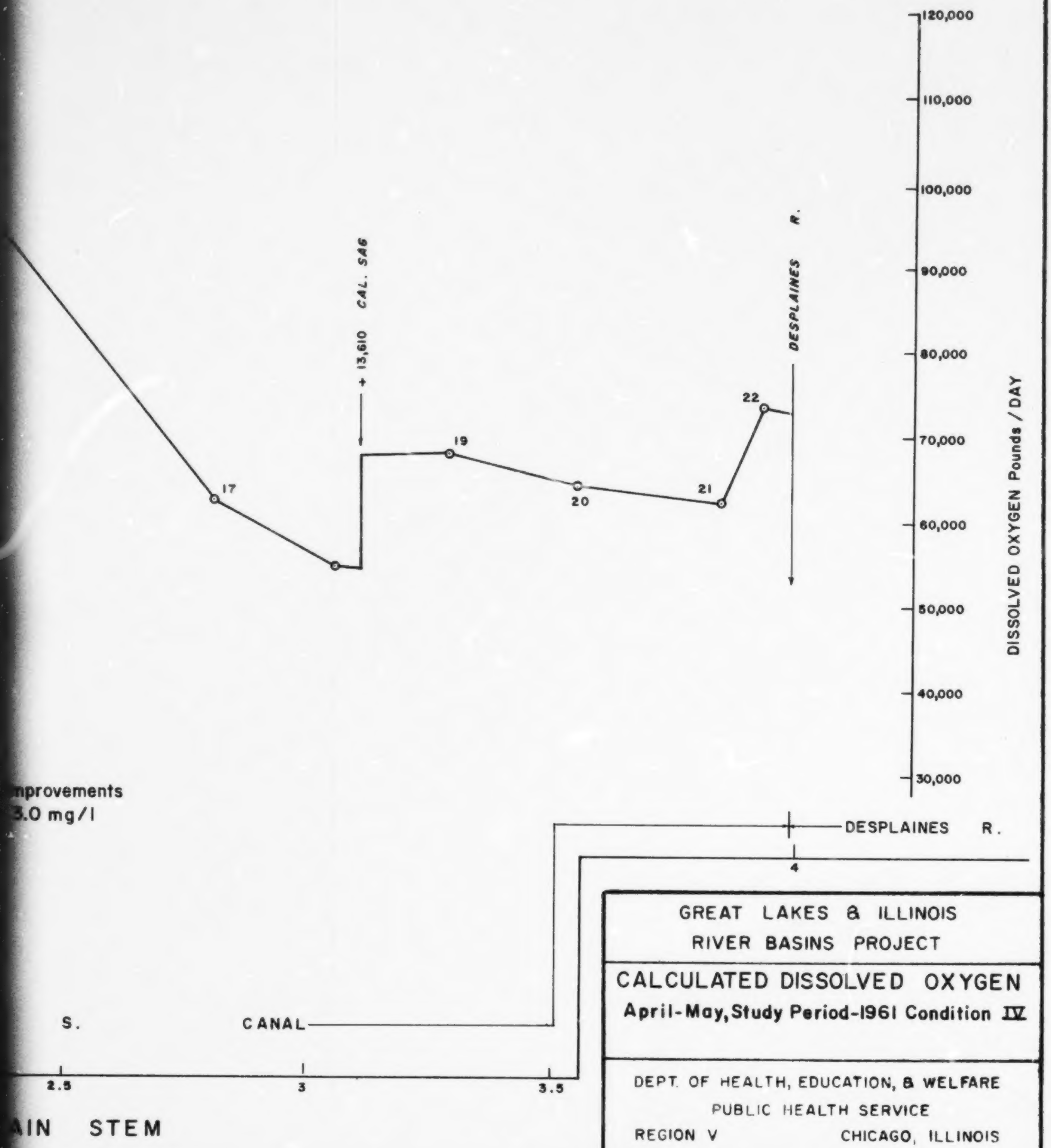

DISSOLVED OXYGEN Pounds / DAY
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
N.S.P. + 14,510
+ 4,970 N. BRANCH
+ 35,040 CHICAGO R.
1
2
3
4
5
6
7
8
9
12
13
14
N.S CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
TIME OF TRAVEL DAYS FROM NO.
Condition IV Inc
With Adjusted Dil
Estimated Direct
Sampling Sta. No
20

B



W.S.W.P. + 47,930
CAL. SAG
+ 13,610
13
14
15
16
17
19
20
LEGEND
Condition IV Includes Recommended Improvements
With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
○20 Sampling Sta. No
BRANCH
S.
&
S.
CANAL
1.5
2
2.5
3
3.5
RAVEL DAYS FROM NO. 1 DOWN MAIN STEM
CA
A

C



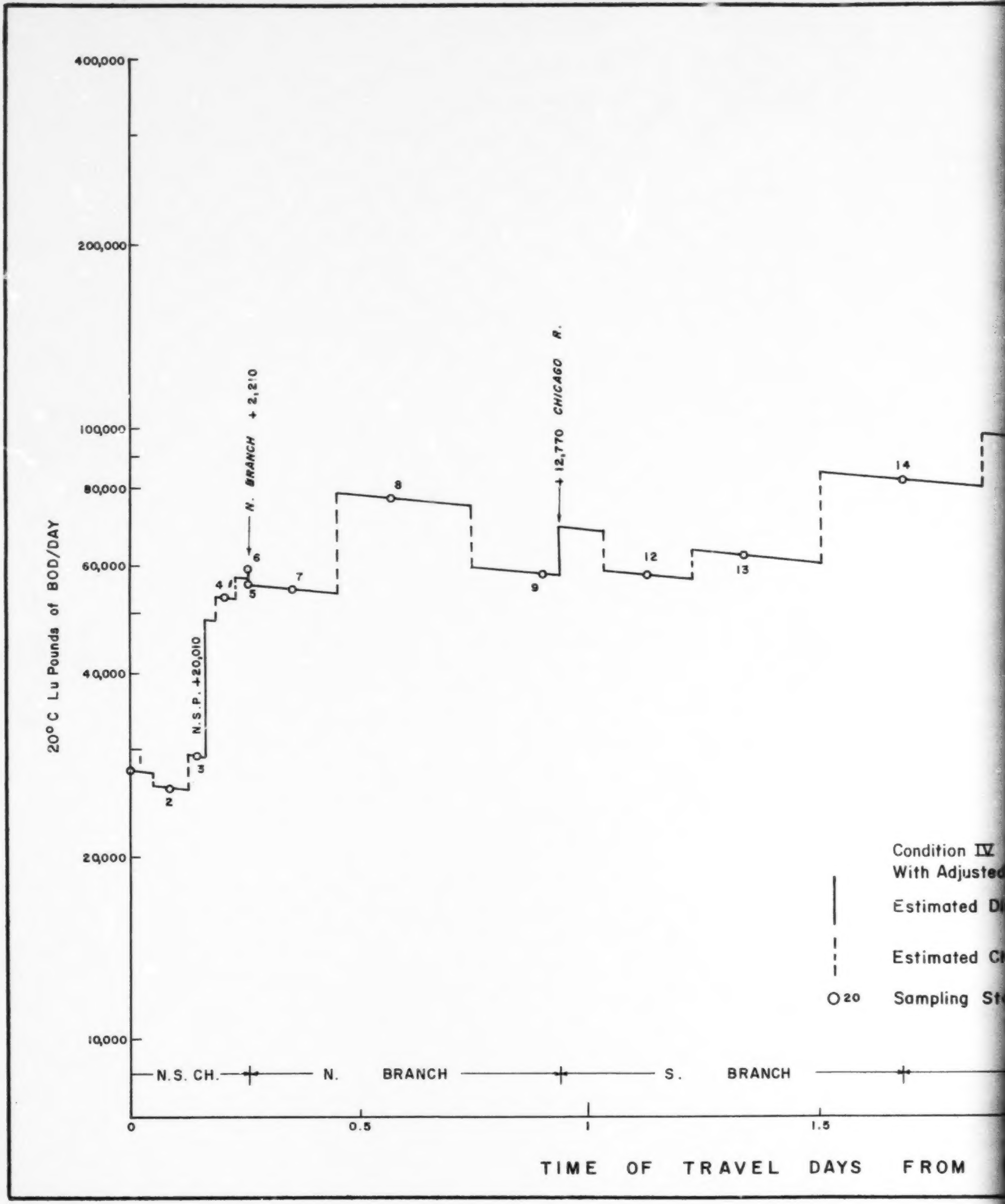
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

CALCULATED DISSOLVED OXYGEN
April-May, Study Period-1961 Condition IV

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

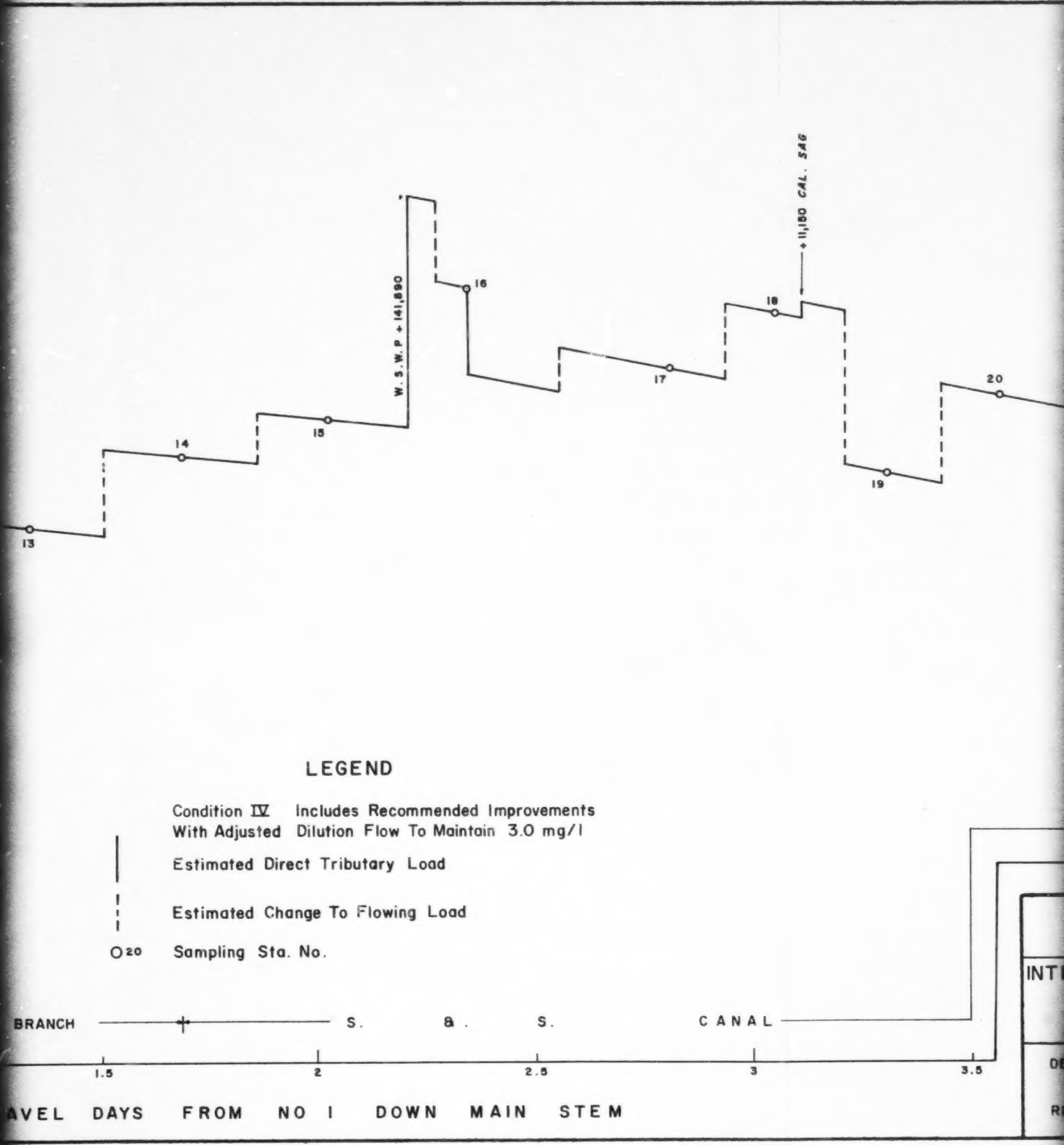
FIGURE 12

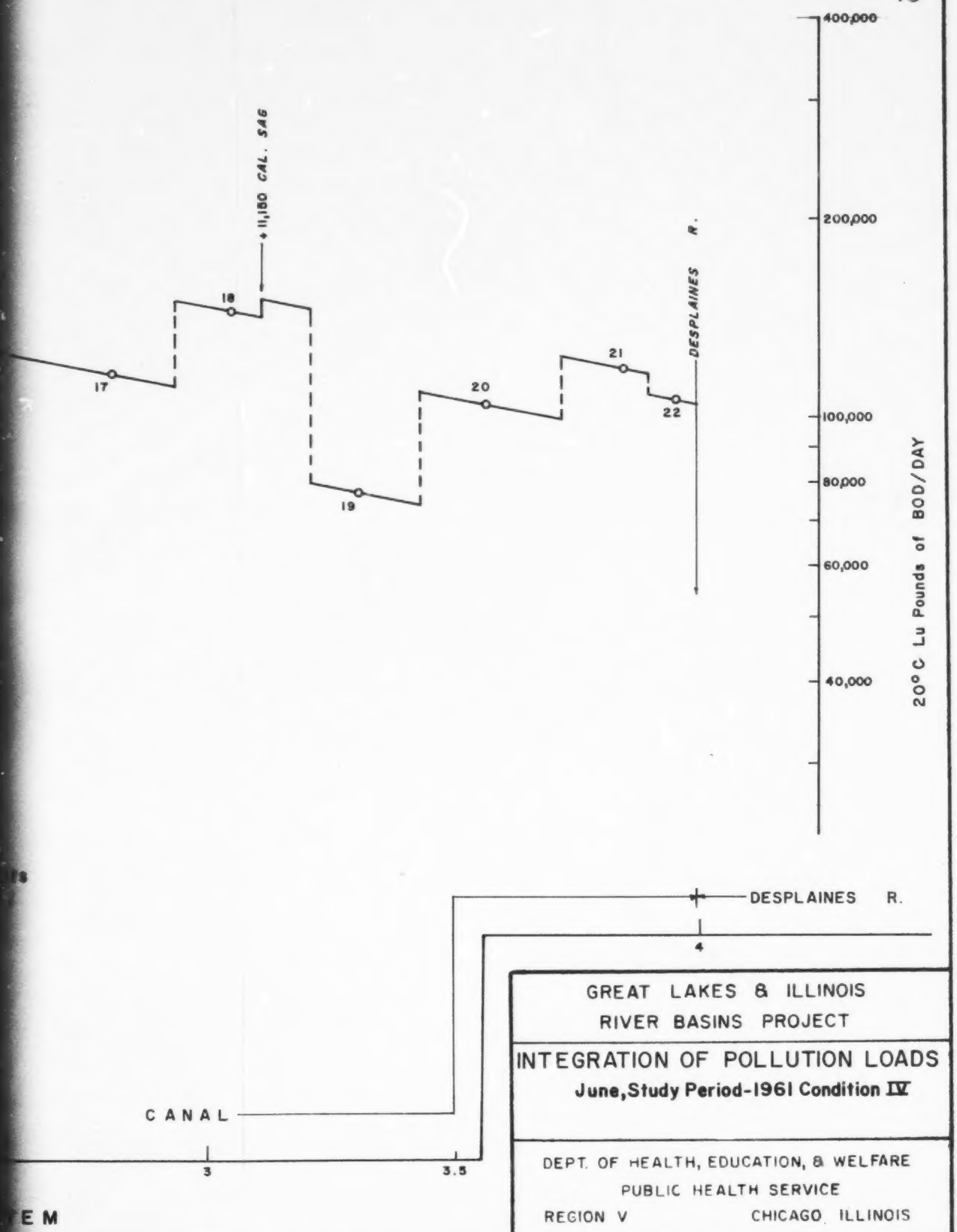
A



400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
20° C Lu Pounds of BOD/DAY
N. BRANCH + 2,210
+ 12,770 CHICAGO R.
N.S.P. +20,010
1
2
3
4
5
6
7
8
9
12
13
14
Condition IV
With Adjusted
Estimated D
Estimated C
20
Sampling St
N.S. CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
TIME OF TRAVEL DAYS FROM

B


13
14
15
W. S. W. P. + 141,890
16
17
18
+ 11,150 CAL. SAG
19
20
LEGEND
Condition IV Includes Recommended Improvements With Adjusted Dilution Flow To Maintain 3.0 mg/l
│ Estimated Direct Tributary Load
╎ Estimated Change To Flowing Load
○ 20 Sampling Sta. No.
BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
AVEL DAYS FROM NO 1 DOWN MAIN STEM
INT



GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

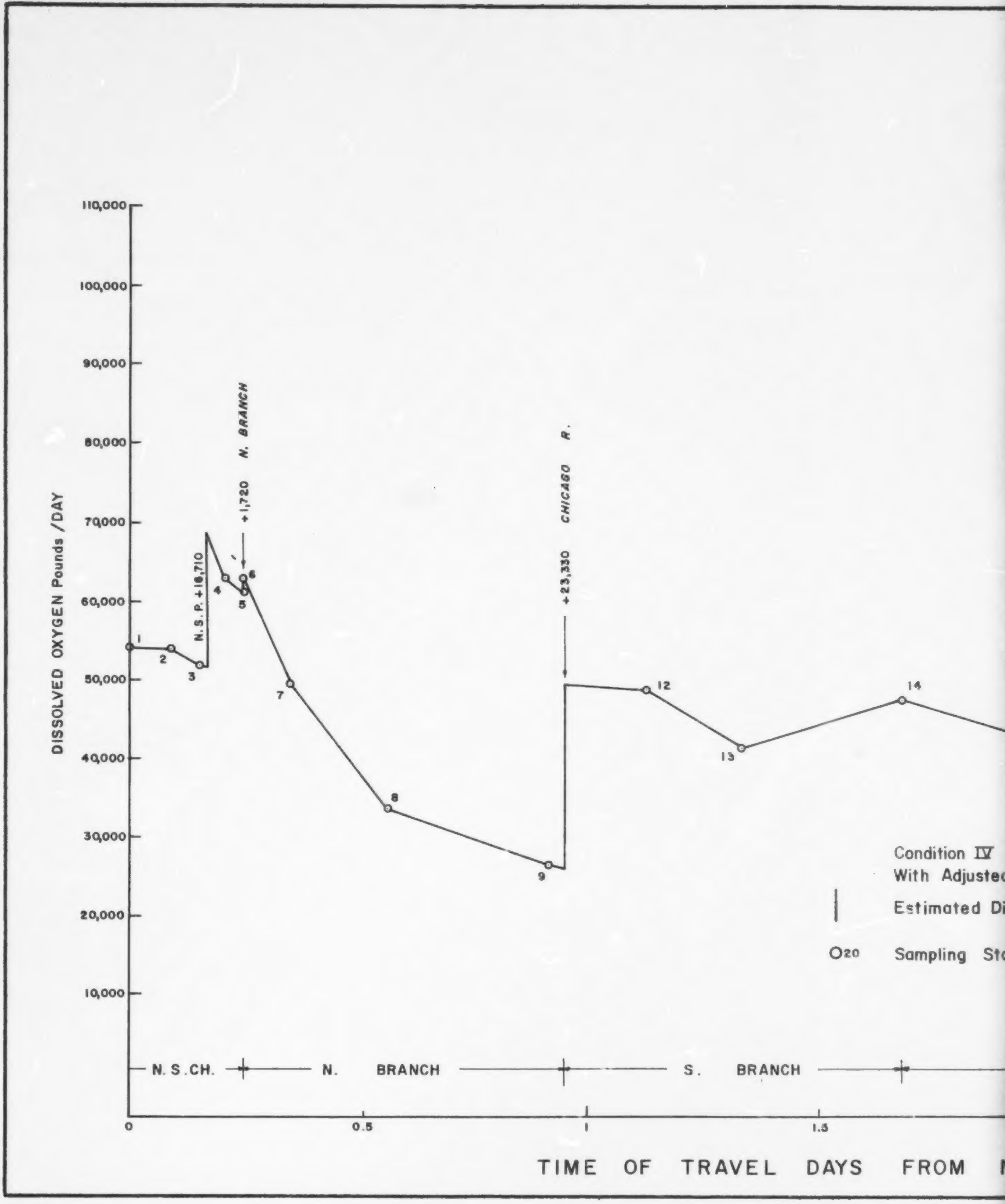
INTEGRATION OF POLLUTION LOADS

June, Study Period-1961 Condition IV

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO ILLINOIS

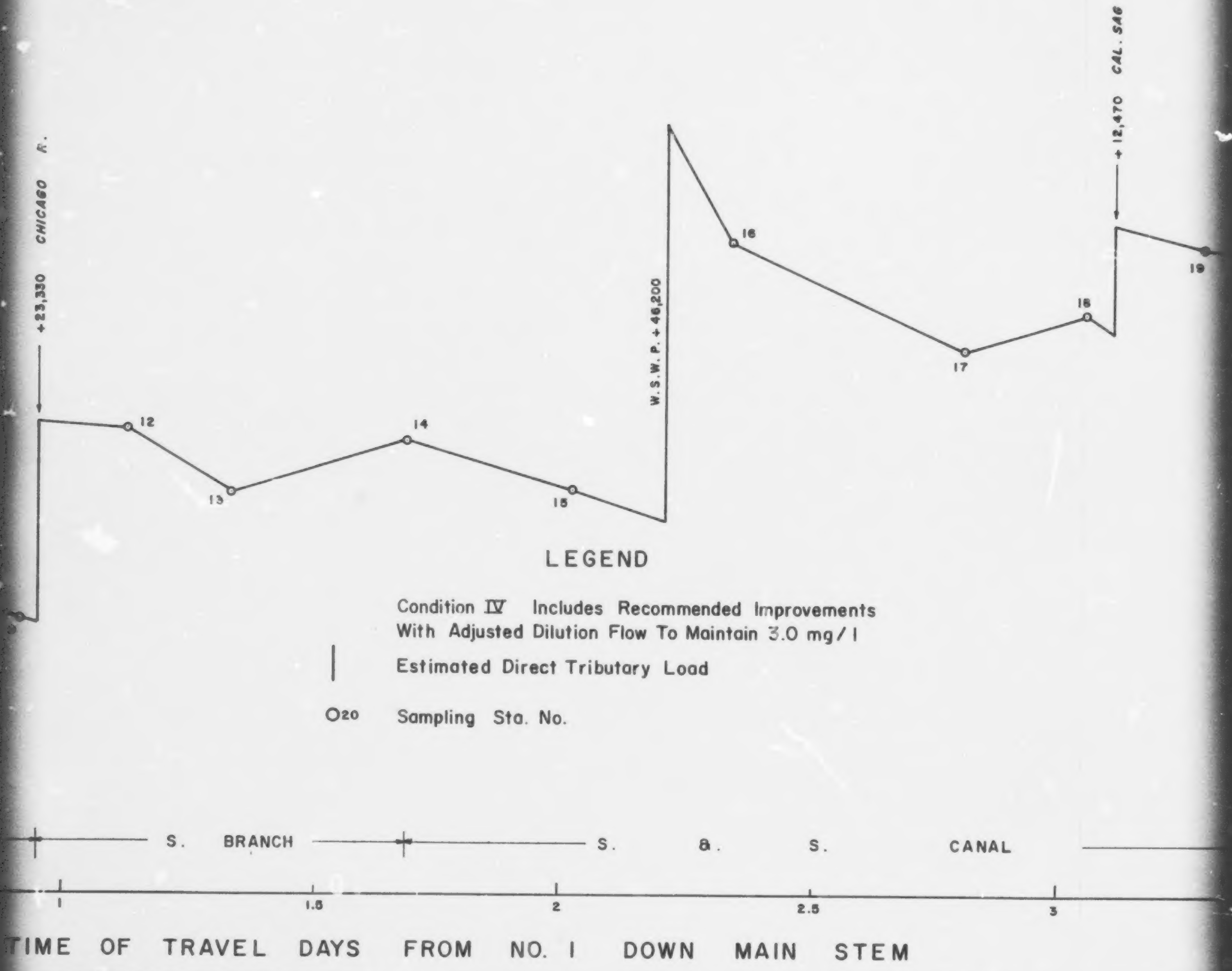
FIGURE 13

A

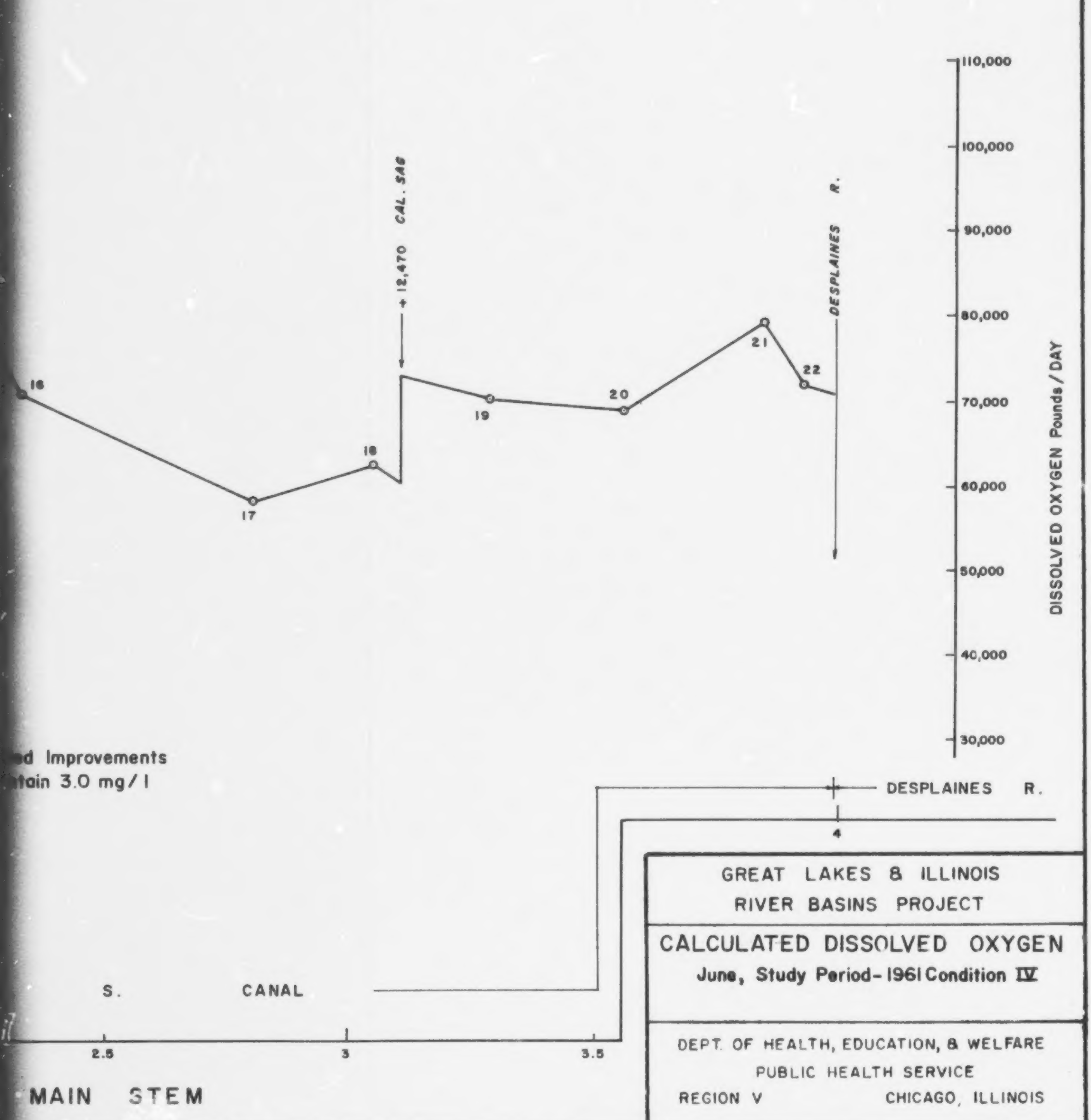

DISSOLVED OXYGEN Pounds /DAY
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
1
2
3
4
5
6
7
8
9
12
13
14
N. S. P. +16,710
+1,720 N. BRANCH
+23,330 CHICAGO R.
Condition IV
With Adjustec
Estimated Di
O20 Sampling Sta
N. S. CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
TIME OF TRAVEL DAYS FROM

GPO 827804

B


CHICAGO R.
+23,330
W.S.W.P. + 46,200
+ 12,470 CAL. SAG
12
13
14
15
16
17
18
19
LEGEND
Condition IV Includes Recommended Improvements
With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
O20 Sampling Sta. No.
S. BRANCH
S. & S. CANAL
1
1.5
2
2.5
3
TIME OF TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

C



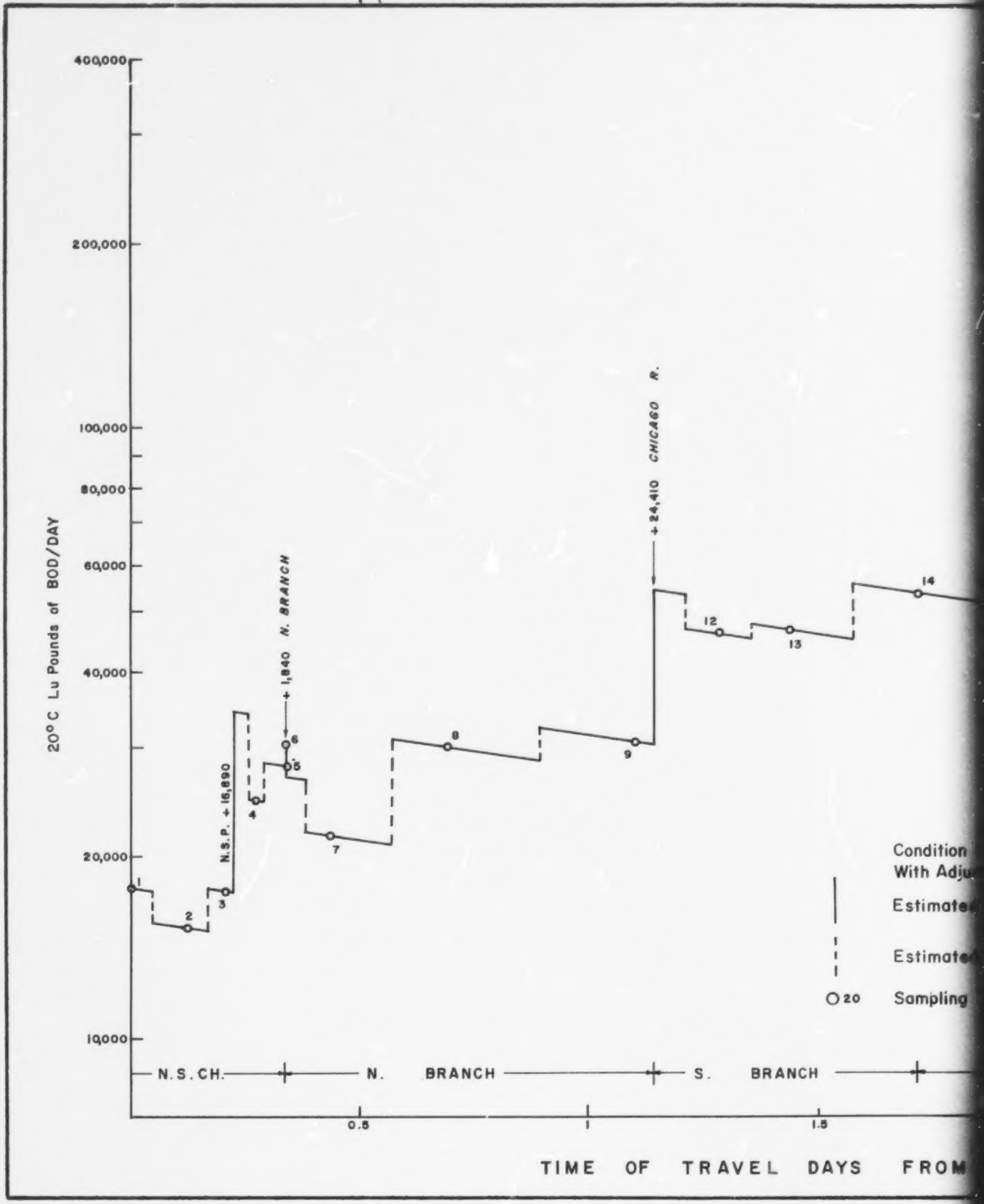
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

CALCULATED DISSOLVED OXYGEN
June, Study Period-1961 Condition IV

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

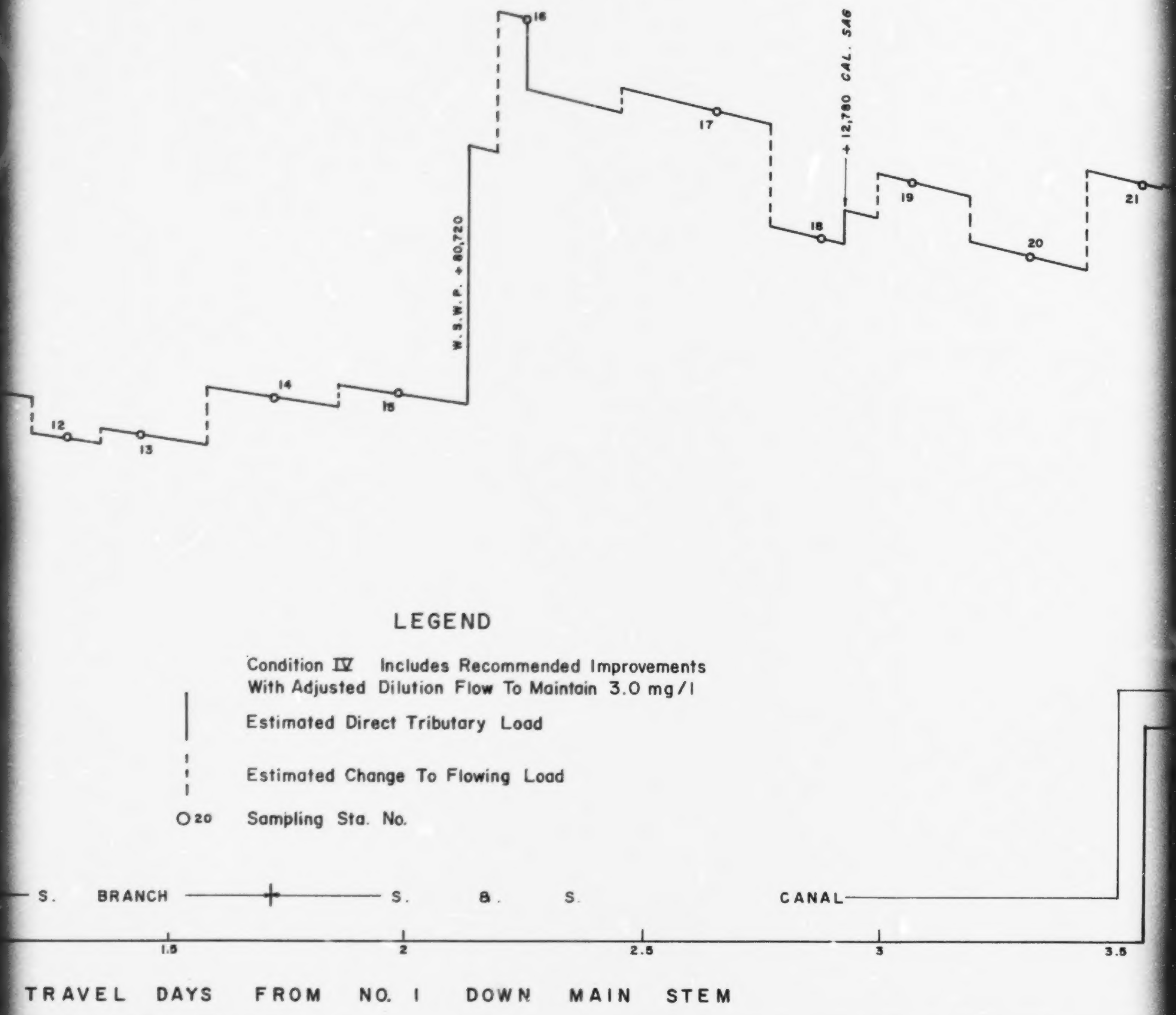
FIGURE 14

A

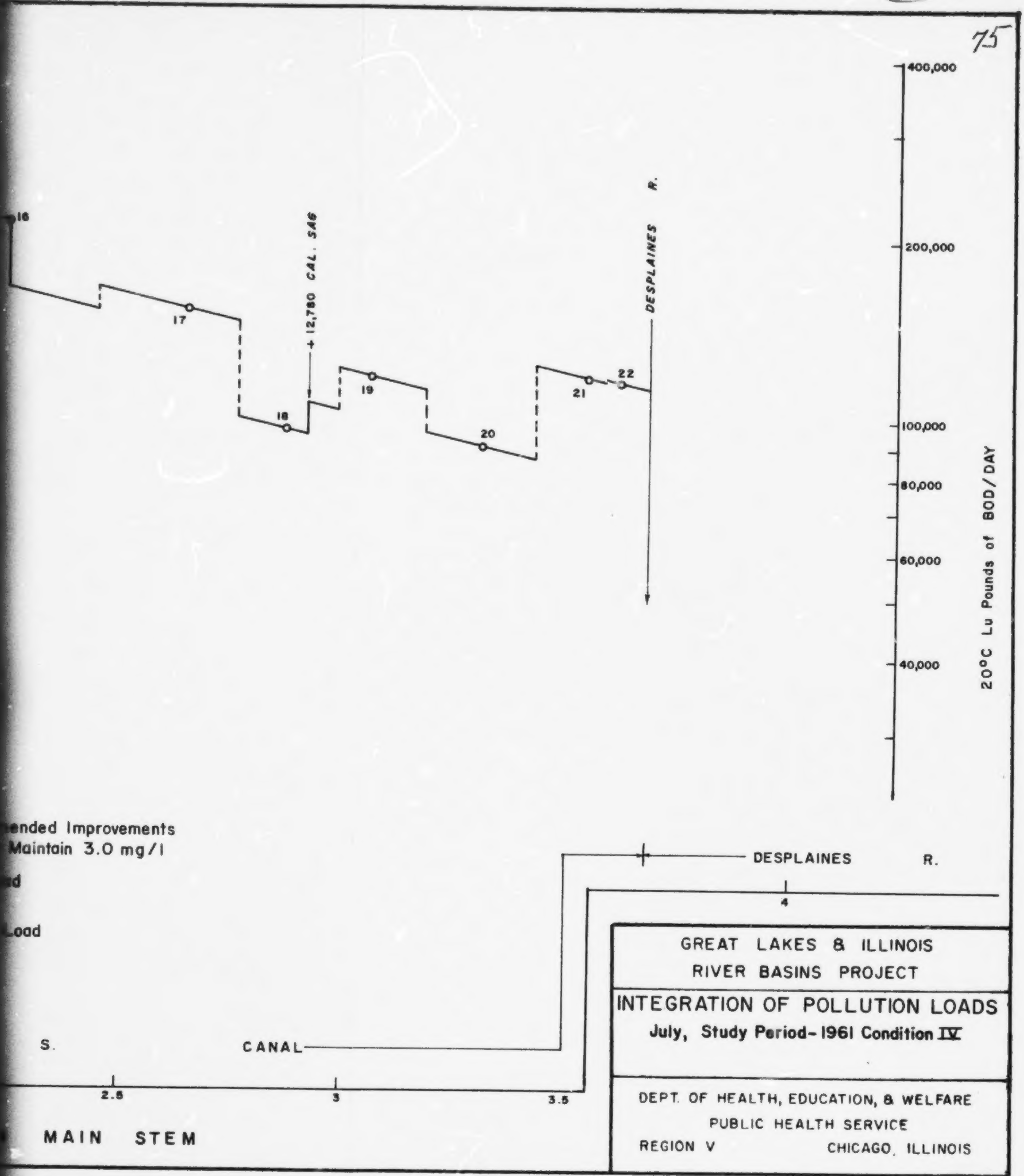


400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
20°C Lu Pounds of BOD/DAY
N.S.P. + 16,890
+ 1,840 N. BRANCH
+ 24,410 CHICAGO R.
1
2
3
4
5
6
7
8
9
12
13
14
Condition
With Adju
Estimate
Estimate
○ 20 Sampling
N.S.CH.
N. BRANCH
S. BRANCH
0.5
1
1.5
TIME OF TRAVEL DAYS FROM

B


16
W.S.W.P. + 80,720
17
+ 12,780 CAL. SAG
18
19
20
21
12
13
14
15
LEGEND
Condition IV Includes Recommended Improvements With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
Estimated Change To Flowing Load
20 Sampling Sta. No.
S. BRANCH
S. B. S.
CANAL
1.5
2
2.5
3
3.5
TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

C



GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

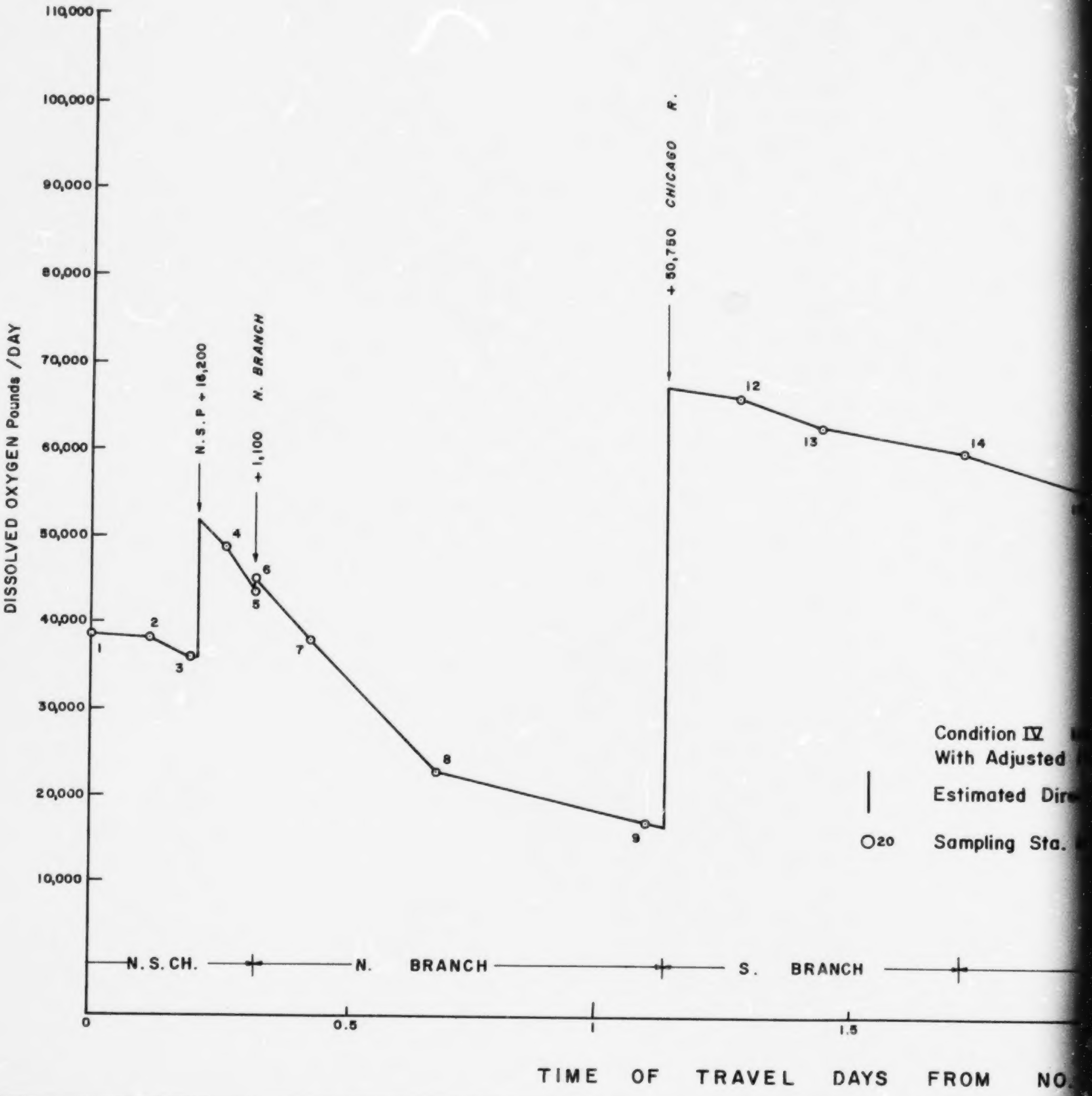
INTEGRATION OF POLLUTION LOADS

July, Study Period-1961 Condition IV

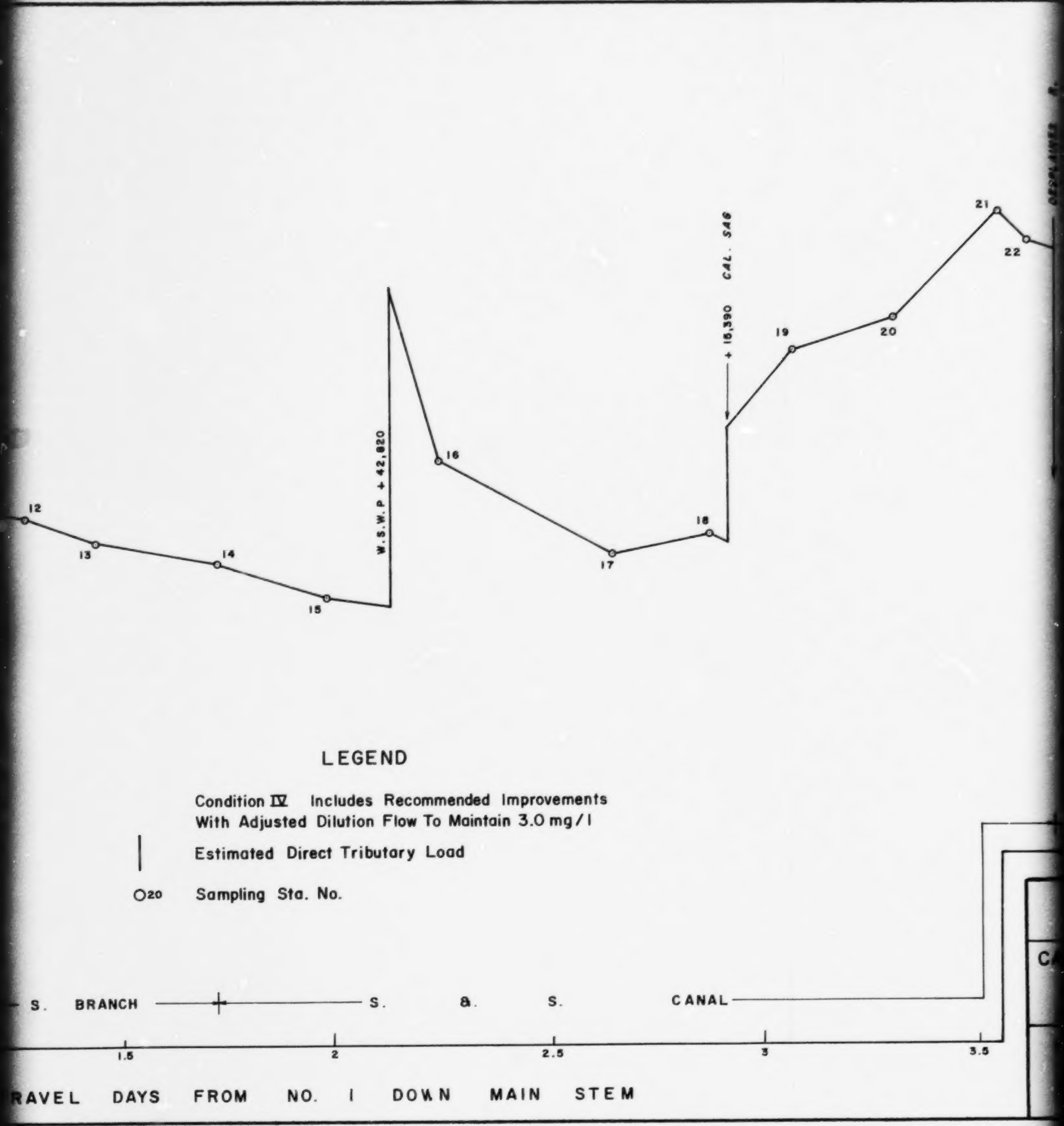
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

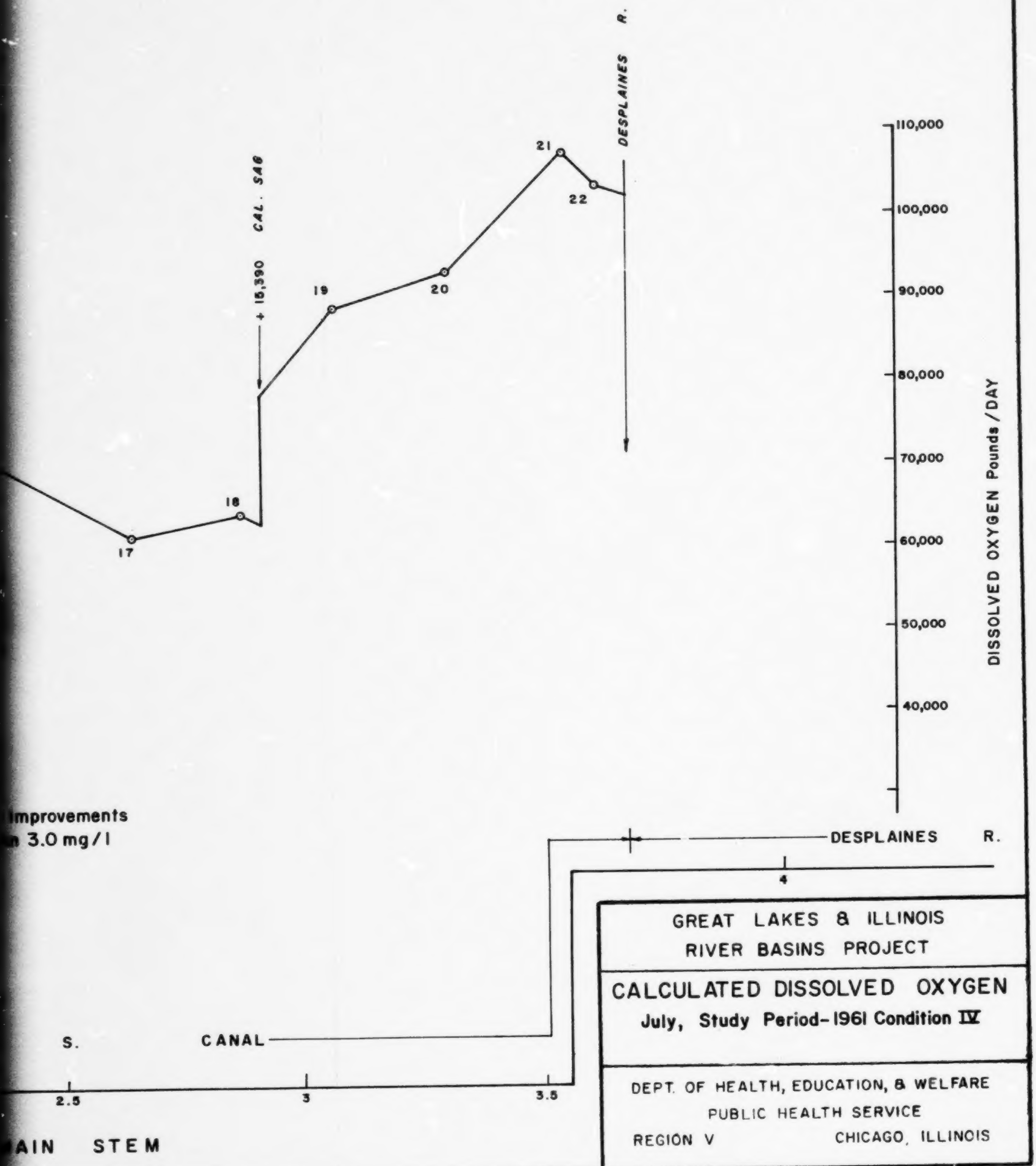
FIGURE 15

A


DISSOLVED OXYGEN Pounds /DAY
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
N. S. P + 16,200
+ 1,100 N. BRANCH
+ 50,750 CHICAGO R.
1
2
3
4
5
6
7
8
9
12
13
14
Condition IV
With Adjusted
Estimated Dir
○20 Sampling Sta.
N. S. CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
TIME OF TRAVEL DAYS FROM NO.

B


12
13
14
15
W.S.W.P + 42,820
16
17
18
+ 16,390 CAL. SAG
19
20
21
22
DESPLAINES R.
LEGEND
Condition IV Includes Recommended Improvements
With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
○20 Sampling Sta. No.
S. BRANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
RAVEL DAYS FROM NO. 1 DOWN MAIN STEM
C



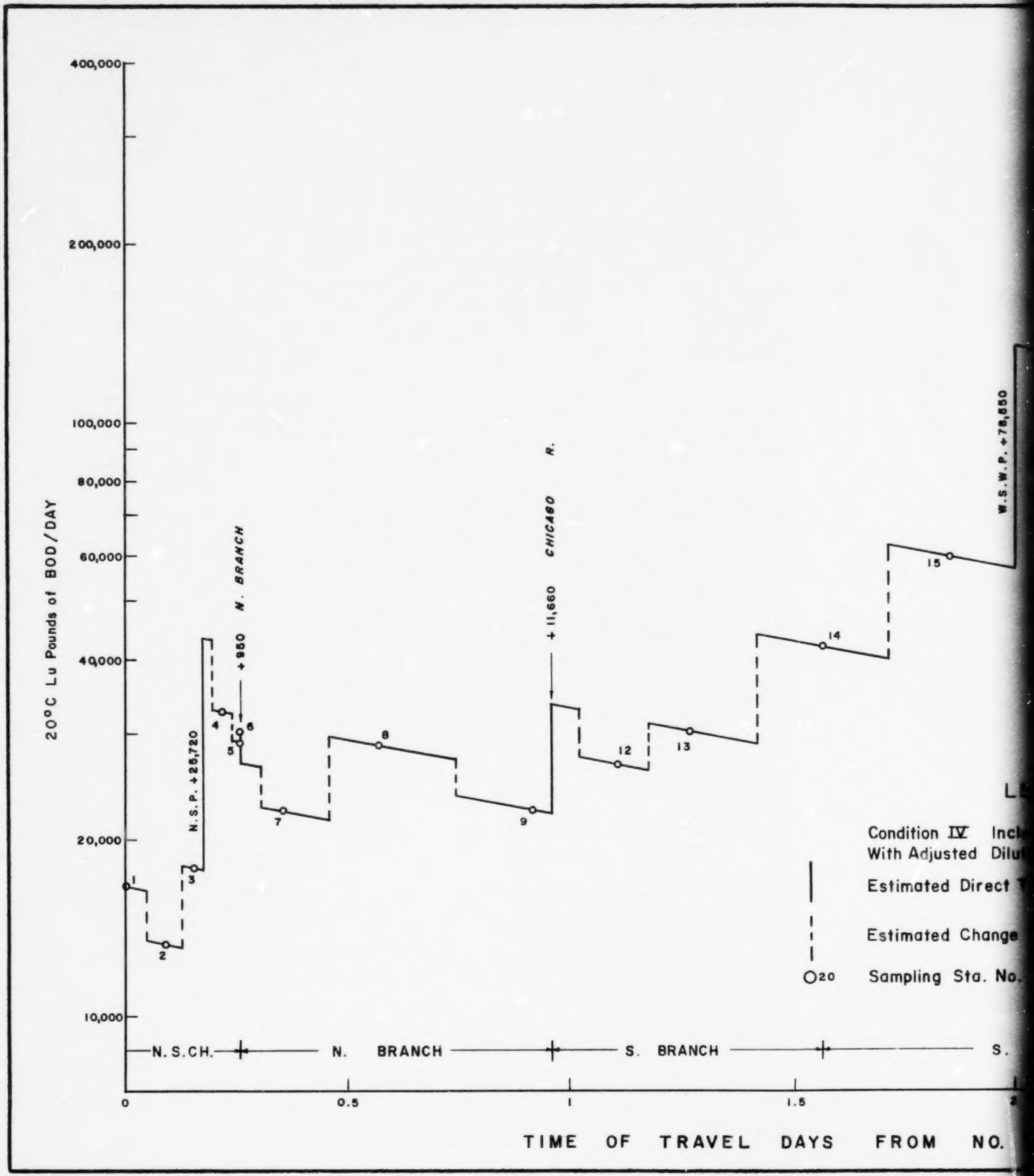
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

CALCULATED DISSOLVED OXYGEN
July, Study Period-1961 Condition IV

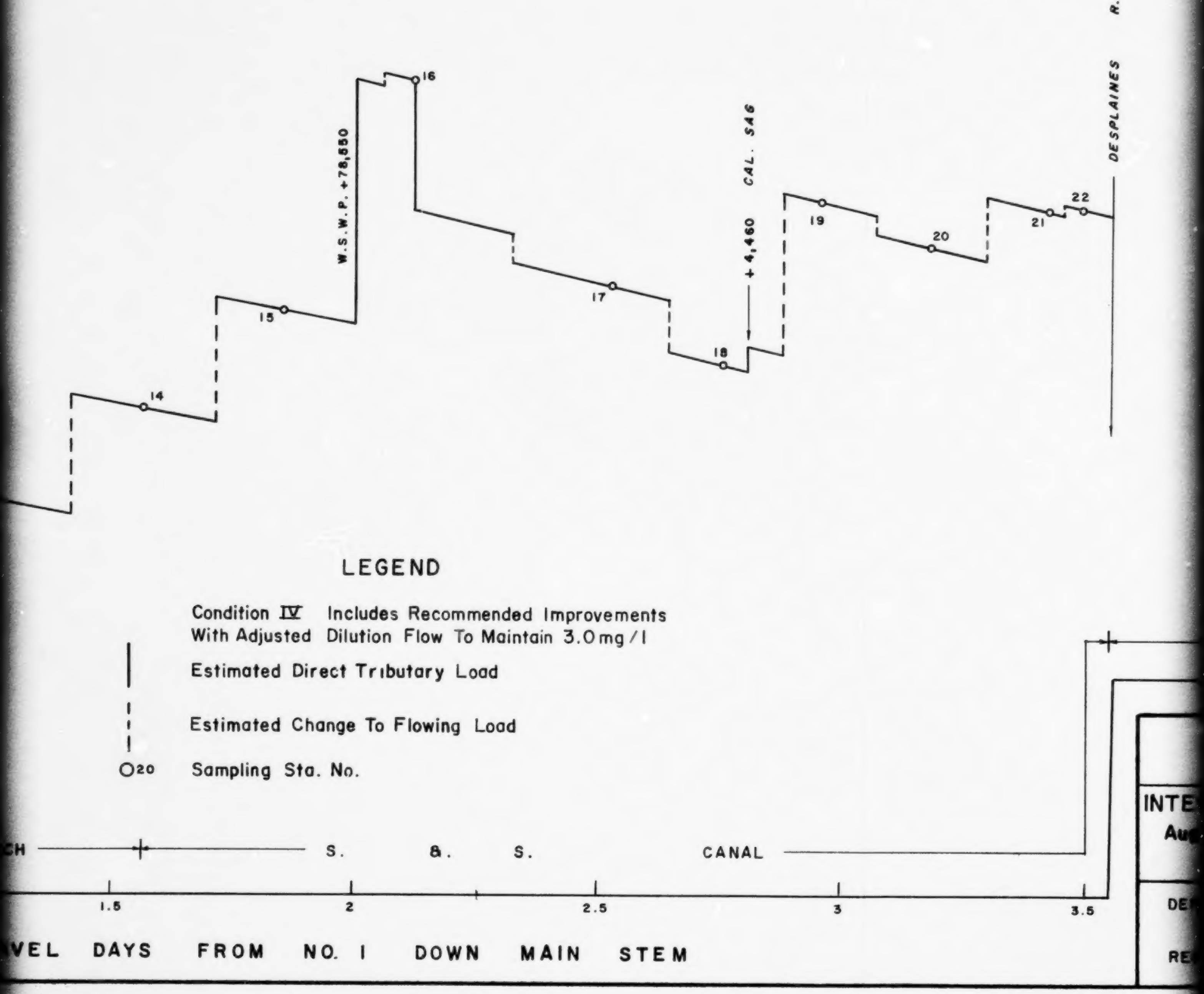
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 16

A

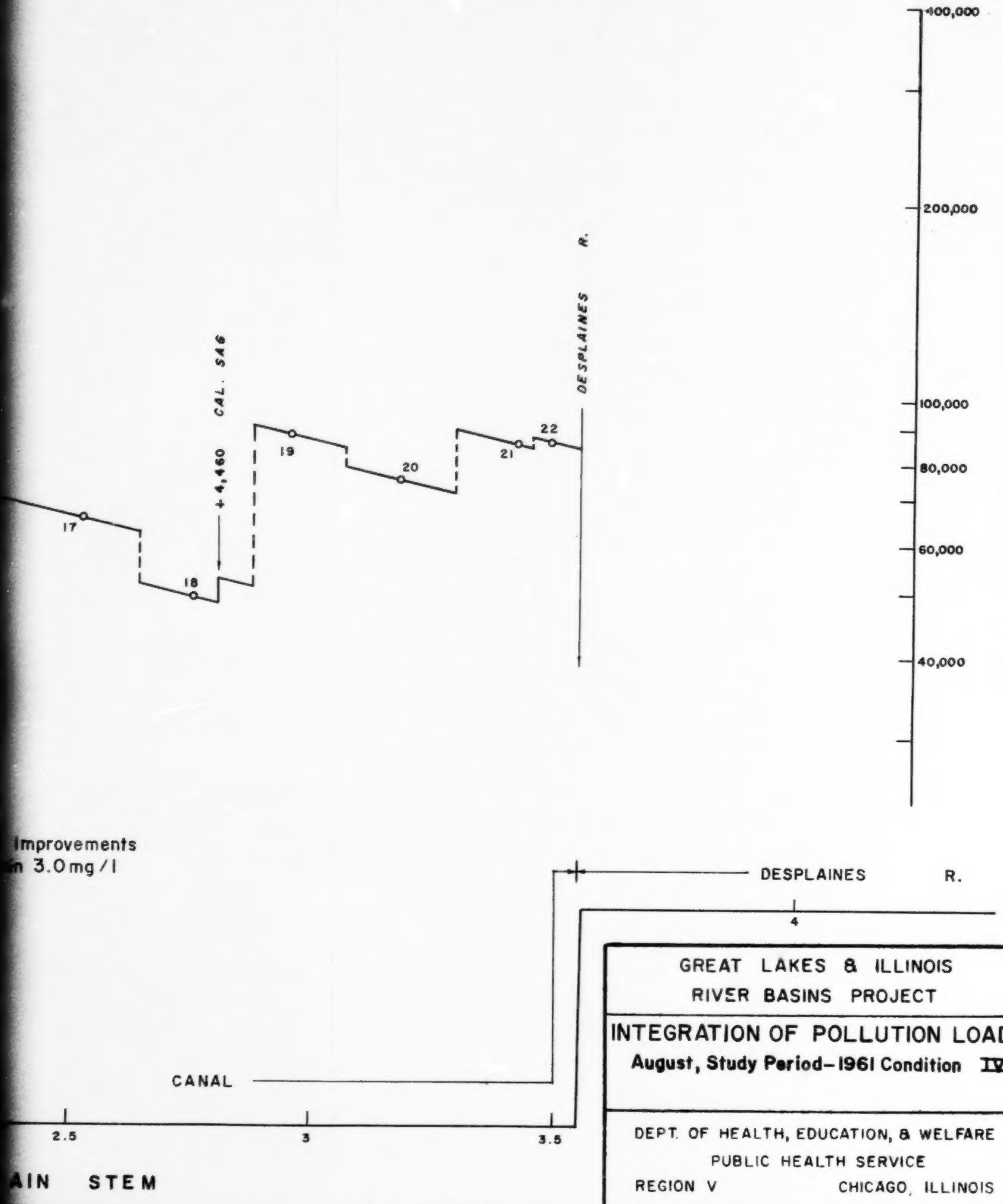

400,000
200,000
100,000
80,000
60,000
40,000
20,000
10,000
20°C Lu Pounds of BOD/DAY
N.S.P. + 25,720
+ 950
N. BRANCH
+ 11,660
CHICAGO R.
W.S.W.P. + 78,850
1
2
3
4
5
6
7
8
9
12
13
14
15
N.S.CH.
N. BRANCH
S. BRANCH
S.
0
0.5
1
1.5
2
TIME OF TRAVEL DAYS FROM NO.
Condition IV Incl
With Adjusted Dilut
Estimated Direct T
Estimated Change
20 Sampling Sta. No.

B


W.S.W.P. +78,550
CAL. SAG
+4,460
DESPLAINES R.
14
15
16
17
18
19
20
21
22
LEGEND
Condition IV Includes Recommended Improvements
With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
Estimated Change To Flowing Load
Sampling Sta. No.
CH
S. & S. CANAL
1.5
2
2.5
3
3.5
VEL DAYS FROM NO. 1 DOWN MAIN STEM
INTE
Aug
DE
RE

C

77



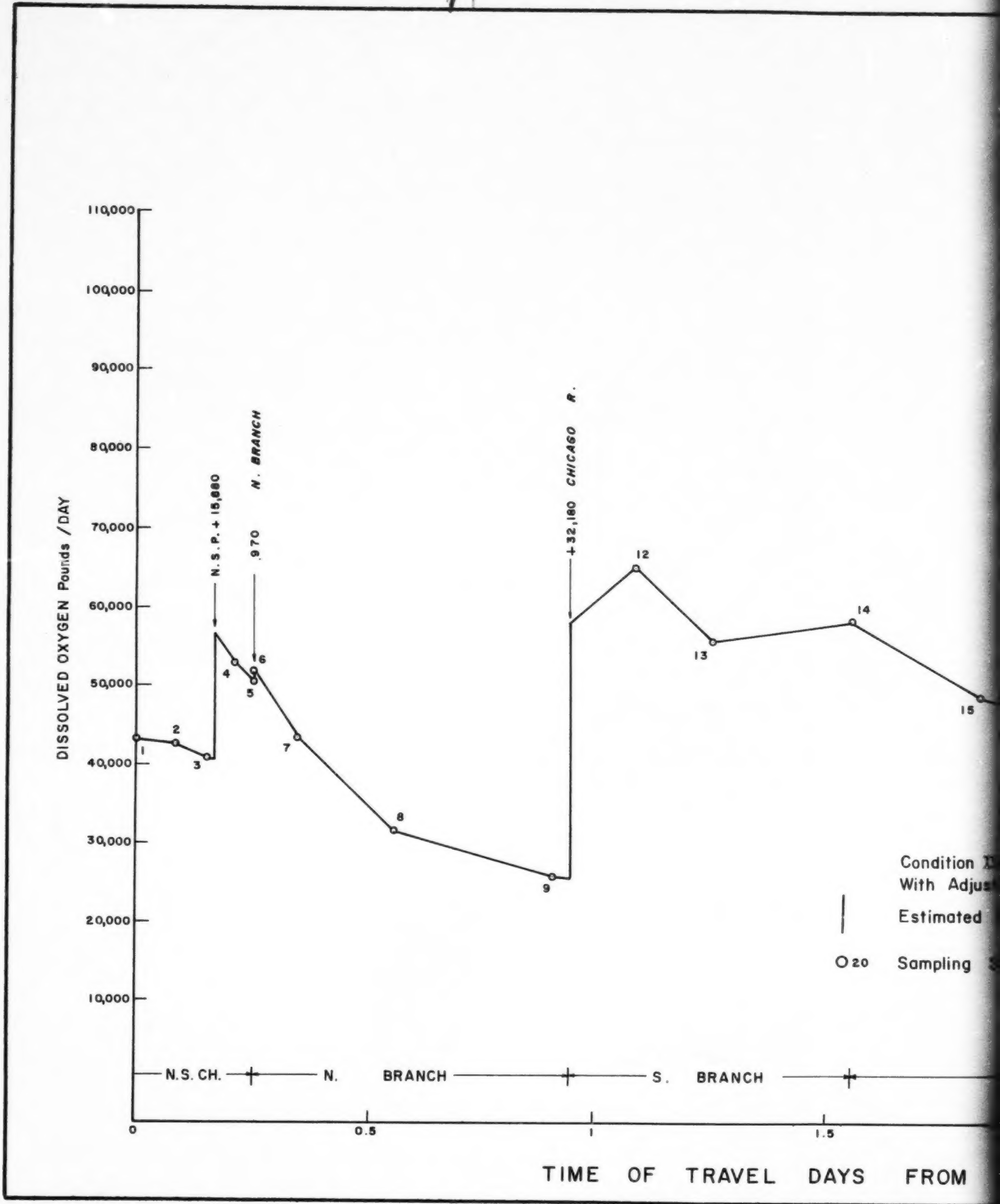
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
August, Study Period-1961 Condition IV

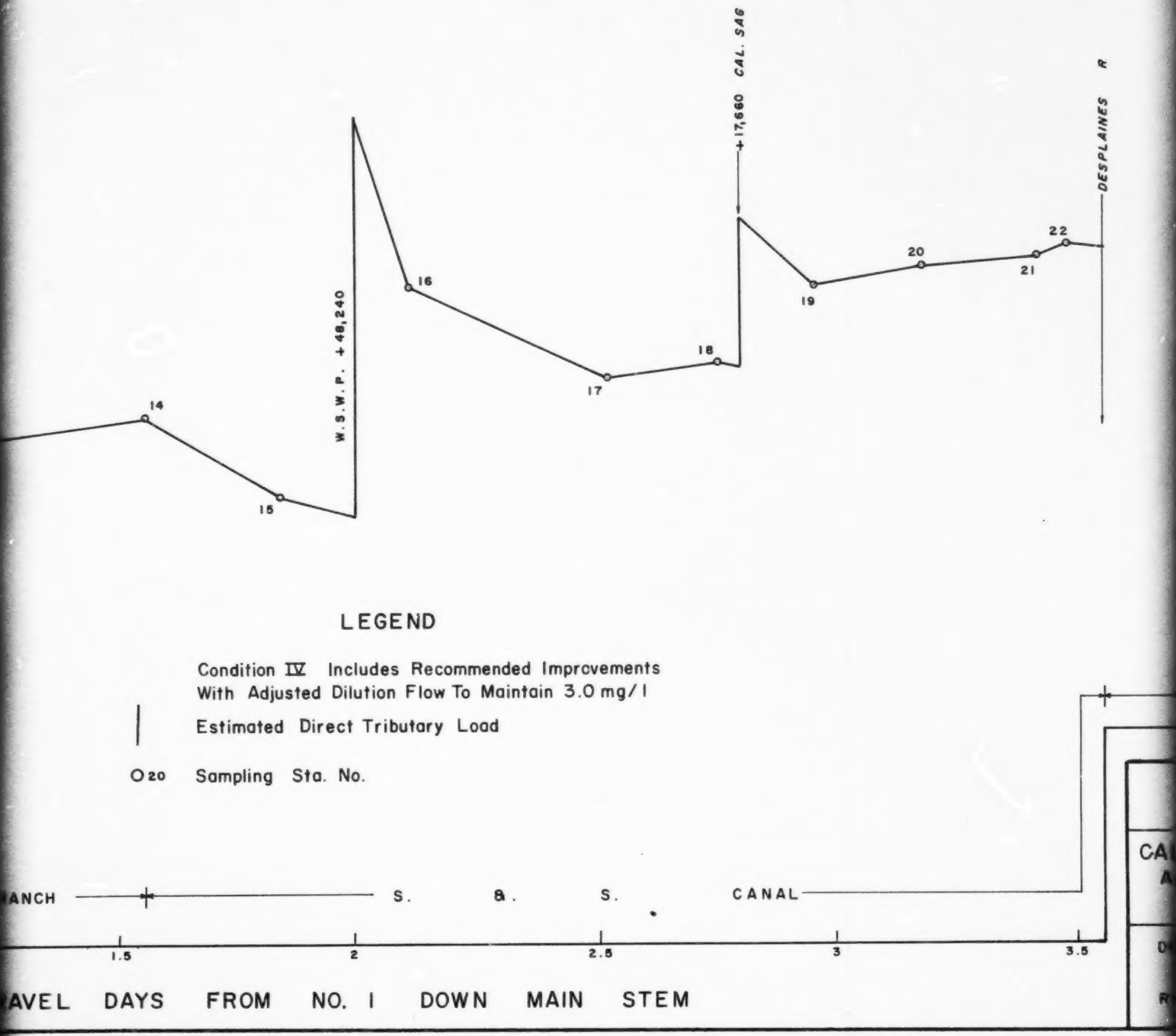
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 17

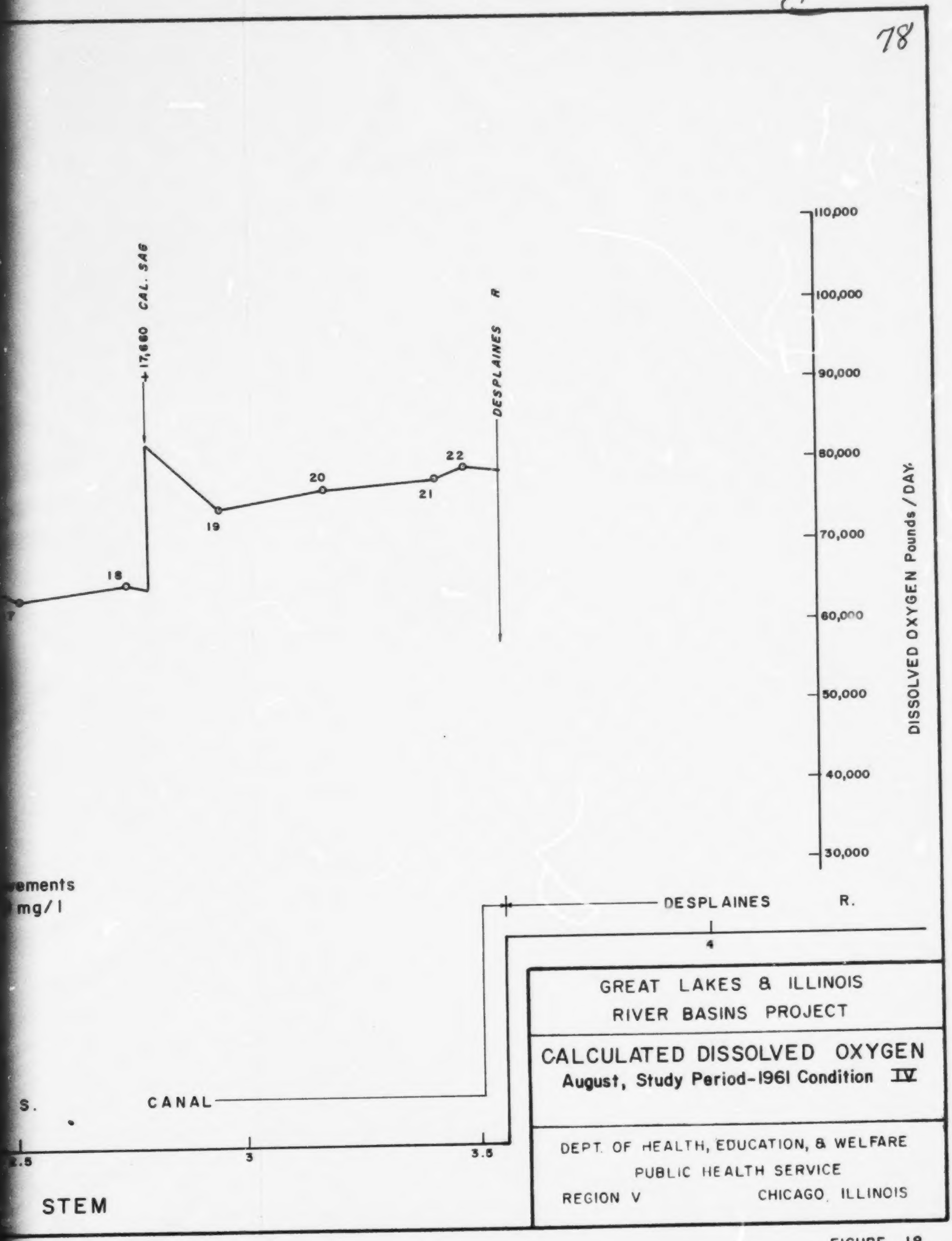
A


DISSOLVED OXYGEN Pounds /DAY
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
N.S.P. + 15,880
N. BRANCH
.970
CHICAGO R.
+32,180
1
2
3
4
5
16
7
8
9
12
13
14
15
Condition
With Adjus
Estimated
O20 Sampling
N.S. CH.
N. BRANCH
S. BRANCH
0
0.5
1
1.5
TIME OF TRAVEL DAYS FROM

B



CAL. SAG
+17,660
DESPLAINES R
W. S. W. P. +48,240
14
15
16
17
18
19
20
21
22
LEGEND
Condition IV Includes Recommended Improvements
With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
O20 Sampling Sta. No.
ANCH
S. & S. CANAL
1.5
2
2.5
3
3.5
AVEL DAYS FROM NO. 1 DOWN MAIN STEM
CA
A
D
R



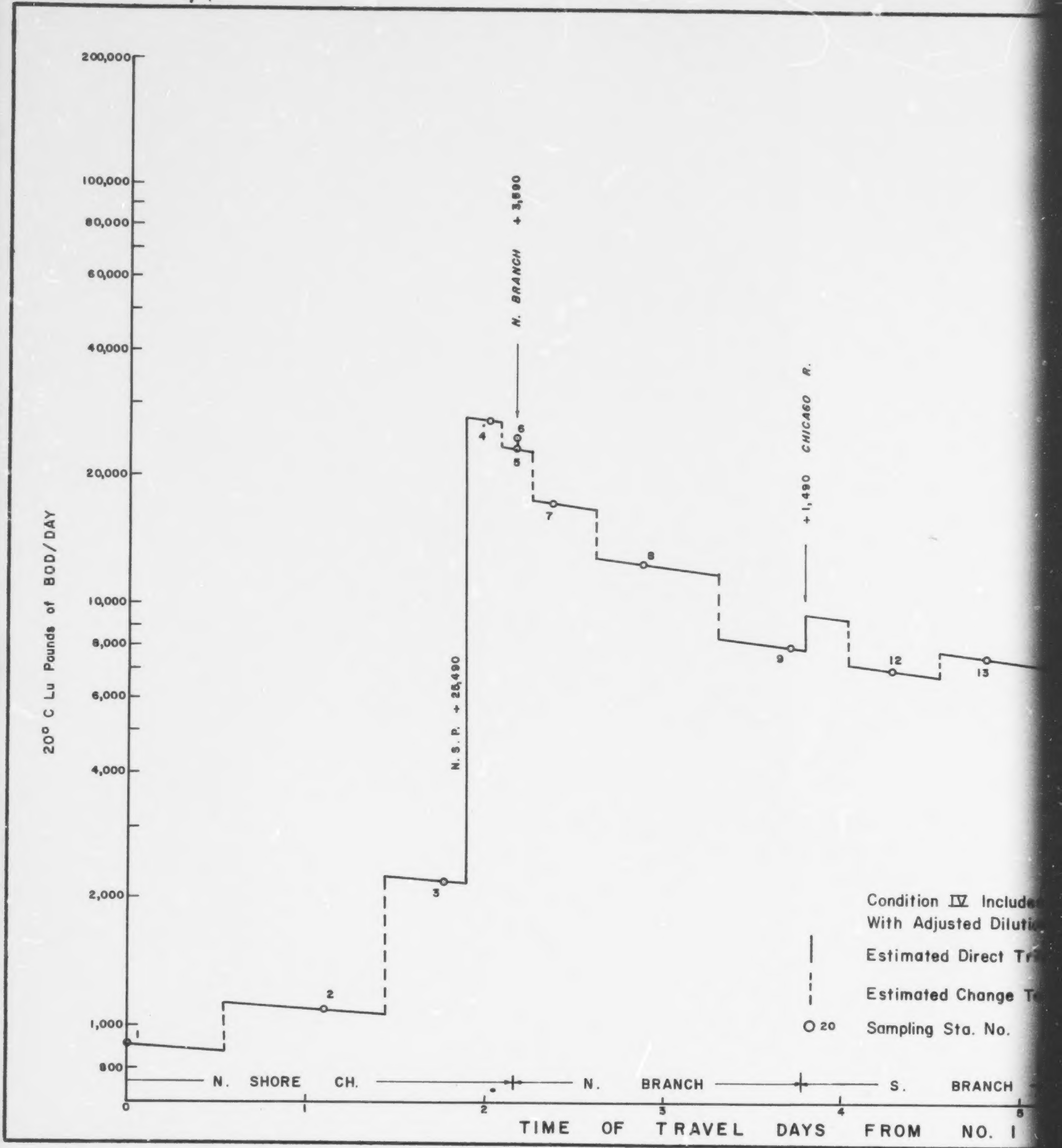
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

CALCULATED DISSOLVED OXYGEN
August, Study Period-1961 Condition IV

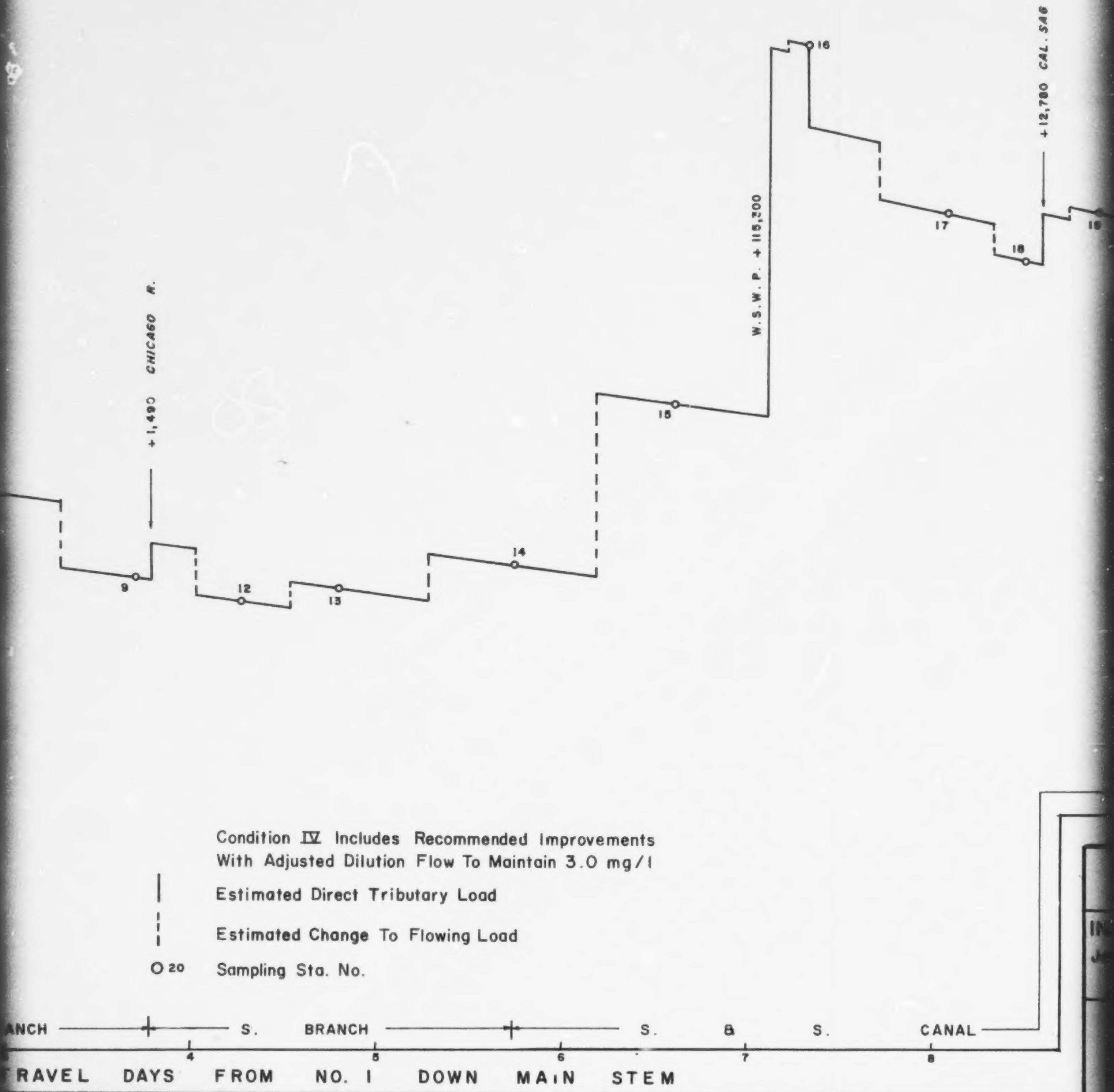
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 18

A

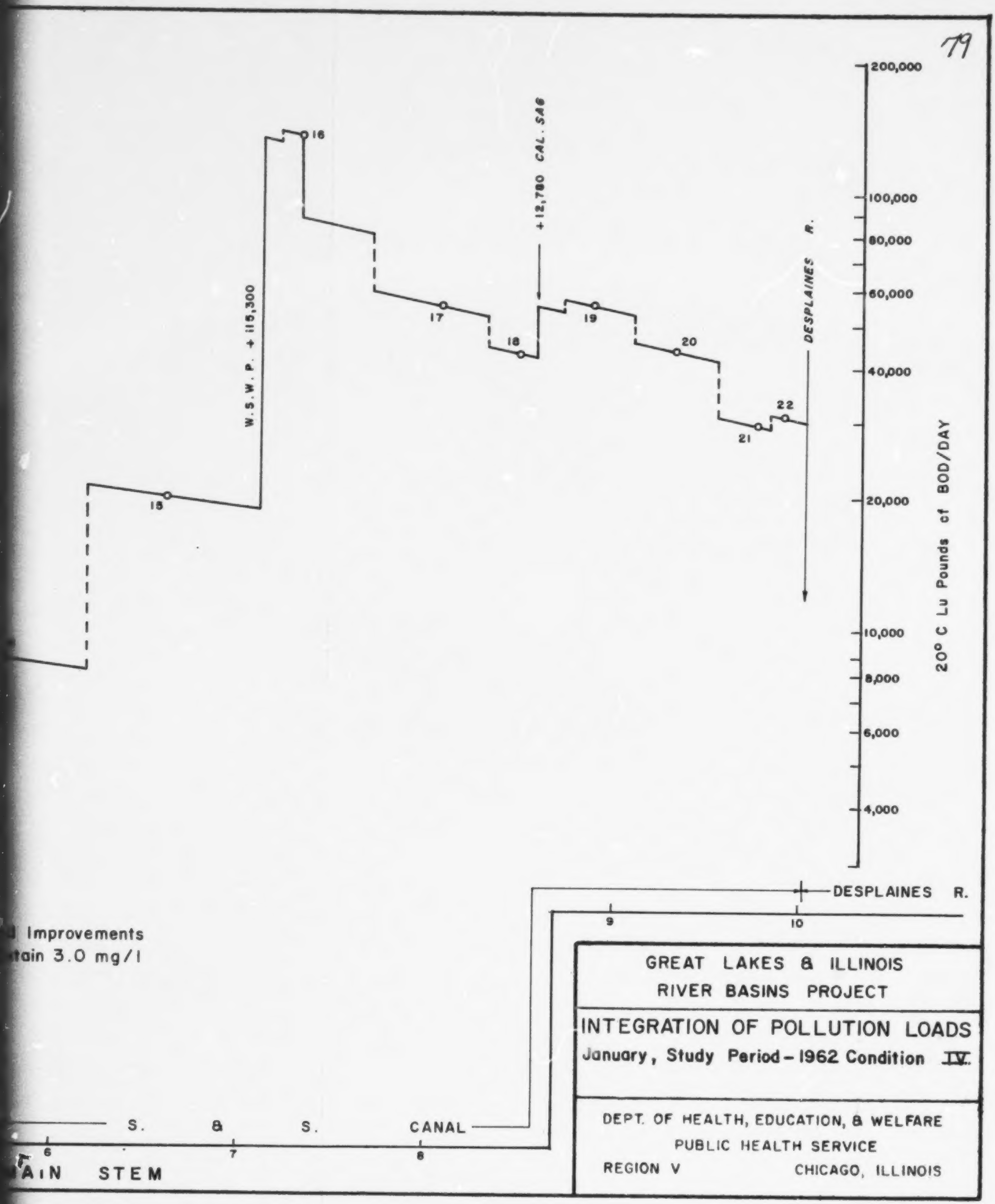

200,000
100,000
80,000
60,000
40,000
20,000
10,000
8,000
6,000
4,000
2,000
1,000
800
20° C Lu Pounds of BOD/DAY
N. S. P. + 25,490
N. BRANCH + 3,590
+ 1,490 CHICAGO R.
1
2
3
4
5
6
7
8
9
12
13
N. SHORE CH.
N. BRANCH
S. BRANCH
0
1
2
3
4
5
TIME OF TRAVEL DAYS FROM NO. I
Condition IV Includ
With Adjusted Diluti
Estimated Direct Tr
Estimated Change T
○ 20 Sampling Sta. No.

B


+1,490 CHICAGO R.
W. S. W. P. +115,200
+12,780 CAL. SAG
9
12
13
14
15
16
17
18
19
Condition IV Includes Recommended Improvements With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
Estimated Change To Flowing Load
O 20 Sampling Sta. No.
ANCH
S. BRANCH
S. & S. CANAL
4
5
6
7
8
TRAVEL DAYS FROM NO. 1 DOWN MAIN STEM

C

79



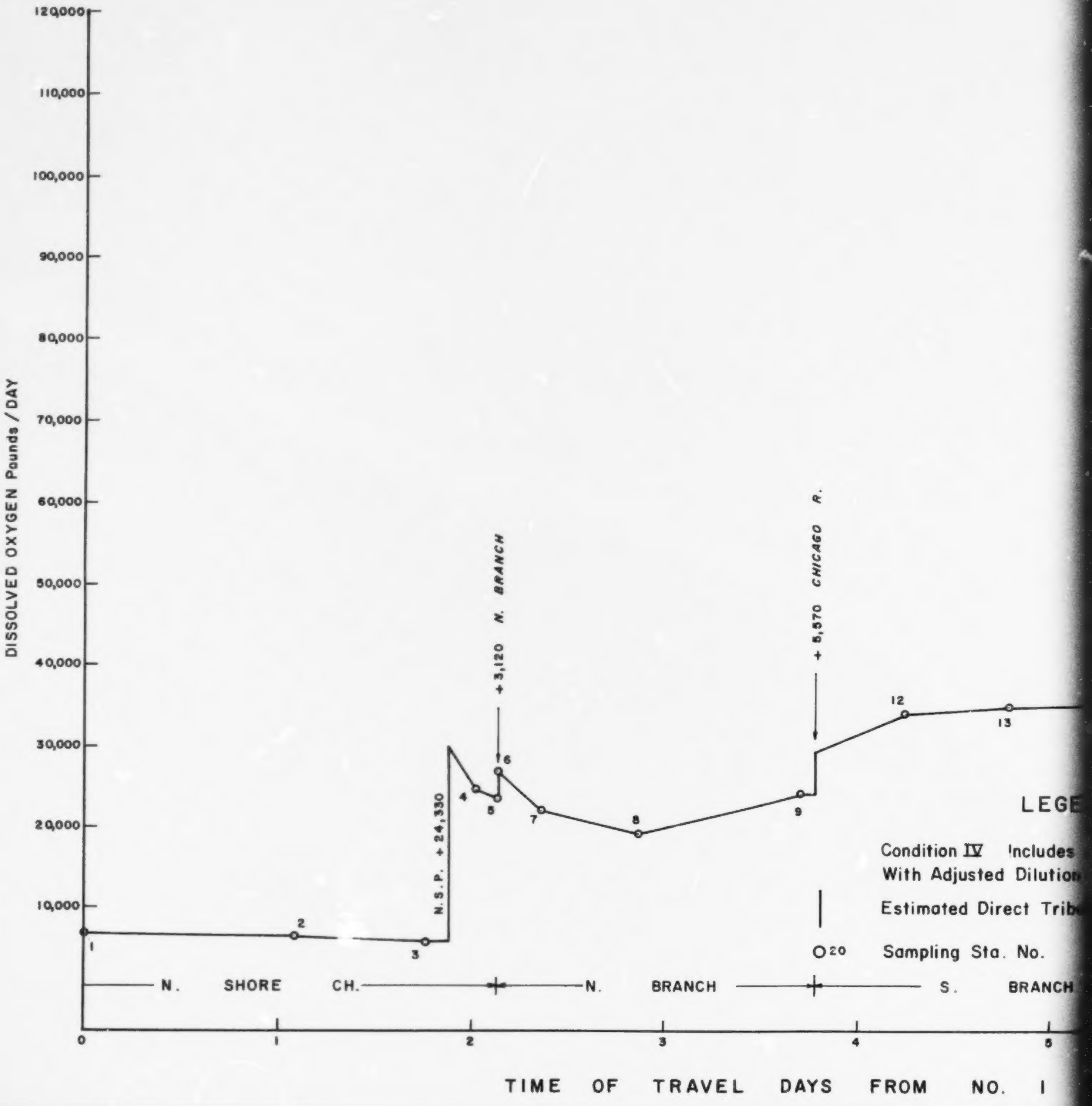
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

INTEGRATION OF POLLUTION LOADS
January, Study Period - 1962 Condition IV.

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

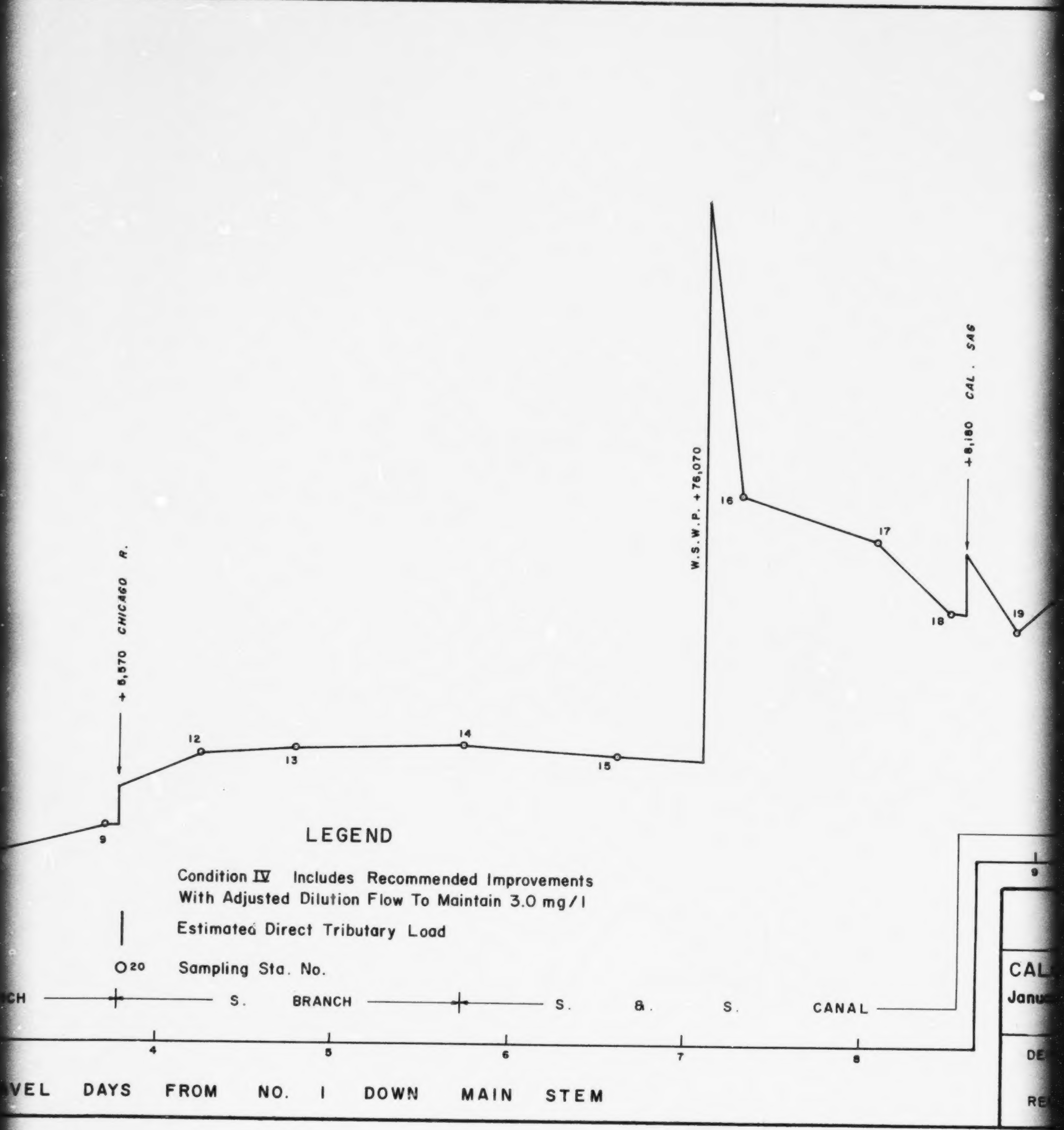
FIGURE 19

A



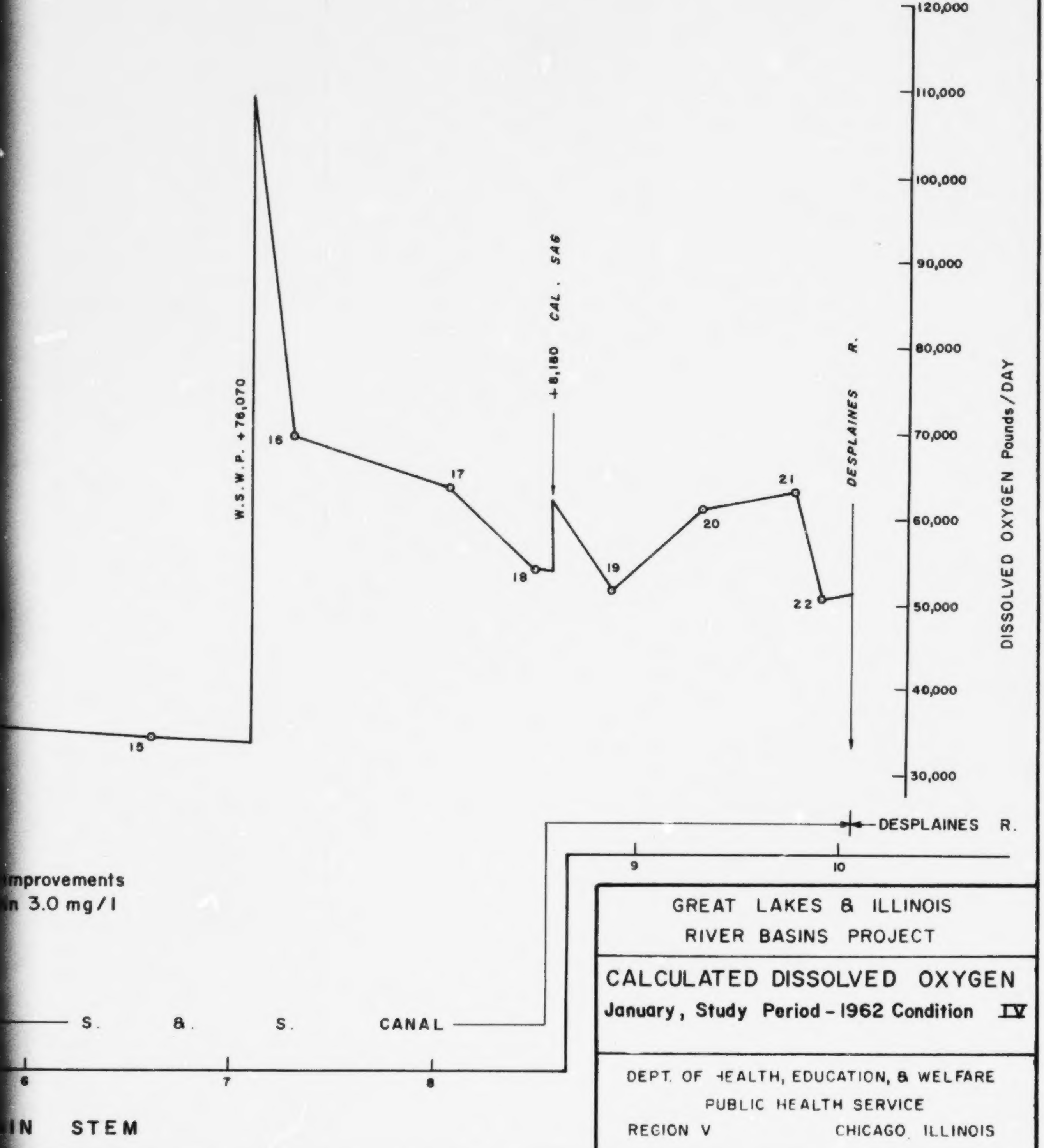
DISSOLVED OXYGEN Pounds / DAY
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1
2
3
4
5
TIME OF TRAVEL DAYS FROM NO. 1
1
2
3
4
5
6
7
8
9
12
13
N.S.P. + 24,330
+ 3,120 N. BRANCH
+ 5,570 CHICAGO R.
N. SHORE CH.
N. BRANCH
S. BRANCH
LEGE
Condition IV Includes
With Adjusted Dilutio
Estimated Direct Trib
○20 Sampling Sta. No.

B



+ 5,570 CHICAGO R.
W.S.W.P. + 76,070
+ 8,180 CAL. SAG
9
12
13
14
15
16
17
18
19
LEGEND
Condition IV Includes Recommended Improvements With Adjusted Dilution Flow To Maintain 3.0 mg/l
Estimated Direct Tributary Load
○20 Sampling Sta. No.
CH
S. BRANCH
S. & S. CANAL
9
4
5
6
7
8
VEL DAYS FROM NO. 1 DOWN MAIN STEM
CAL
Janua
DE
RE

C



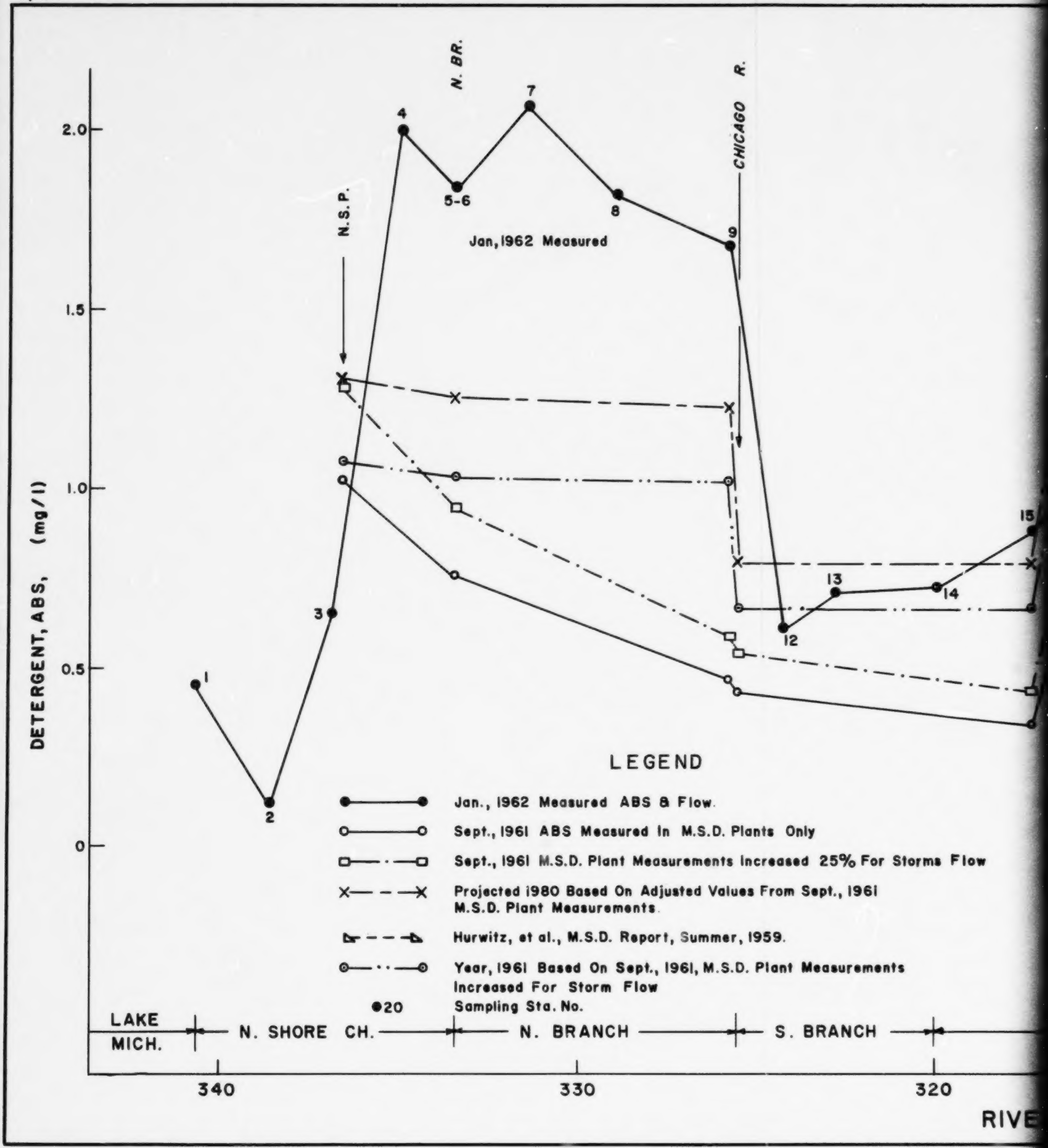
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

CALCULATED DISSOLVED OXYGEN
January, Study Period - 1962 Condition IV

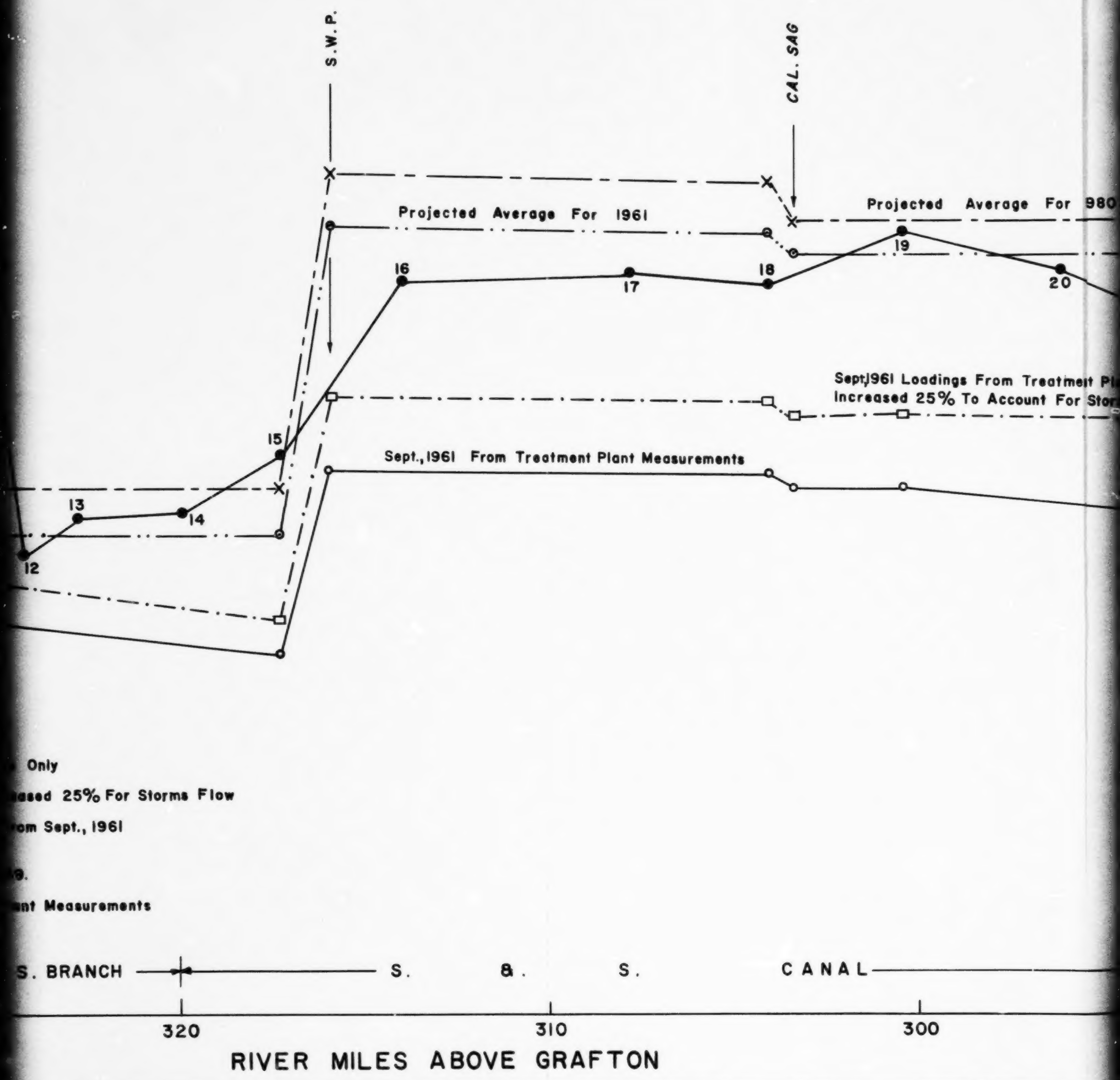
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 20

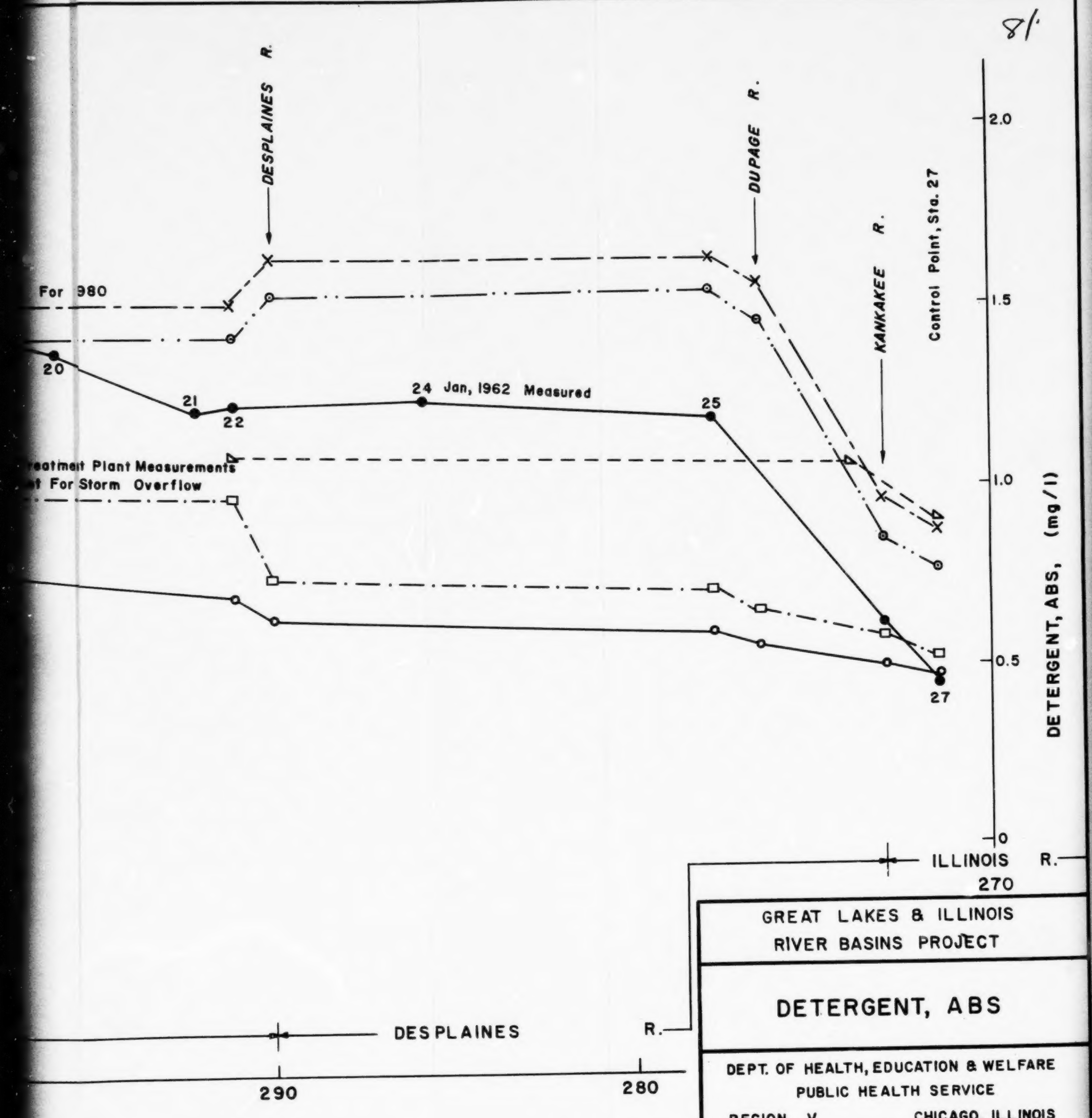
A


DETERGENT, ABS, (mg/l)
2.0
1.5
1.0
0.5
0
N. S. P.
N. BR.
CHICAGO R.
Jan, 1962 Measured
1
2
3
4
5-6
7
8
9
12
13
14
15
LEGEND
Jan., 1962 Measured ABS & Flow.
Sept., 1961 ABS Measured In M.S.D. Plants Only
Sept., 1961 M.S.D. Plant Measurements Increased 25% For Storms Flow
Projected 1980 Based On Adjusted Values From Sept., 1961 M.S.D. Plant Measurements.
Hurwitz, et al., M.S.D. Report, Summer, 1959.
Year, 1961 Based On Sept., 1961, M.S.D. Plant Measurements Increased For Storm Flow
●20 Sampling Sta. No.
LAKE MICH.
N. SHORE CH.
N. BRANCH
S. BRANCH
340
330
320
RIVE

B


S.W.P.
CAL. SAG
Projected Average For 1961
Projected Average For 980
Sept,1961 Loadings From Treatment Pl
Increased 25% To Account For Stor
Sept.,1961 From Treatment Plant Measurements
12
13
14
15
16
17
18
19
20
Only
ased 25% For Storms Flow
rom Sept., 1961
9.
ant Measurements
S. BRANCH
S. & S. CANAL
320
310
300
RIVER MILES ABOVE GRAFTON

C



GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

DETERGENT, ABS

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 21